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## DESCRIPTION

### Information Processing Method and Apparatus, Recording Medium and Program

#### Technical Field

This invention relates to an information processing method and apparatus, a recording medium and a program. More particularly, it relates to an information processing method and apparatus, a recording medium and a program in which the management information for contents of data recorded on a recording medium is formed into a file, which is recorded.

#### Background Art

Recently, a variety of types of optical discs have been proposed as a recording medium that can be removed from a recording apparatus. These recordable optical discs have been proposed as a large capacity medium of several GBs and are thought to be promising as a medium for recording AV (audio visual) signals, such as video signals. Among the digital AV signal sources (supply sources), to be recorded on this recordable optical disc, there are CS digital satellite broadcast and BS digital broadcast. Additionally, the ground wave television broadcast of the digital system has also been proposed for future use.

The digital video signals, supplied from these sources, are routinely compressed under the MPEG (Moving Picture Experts Group) 2 system. In a recording apparatus,

a recording rate proper to the apparatus is set. If digital video signals of the digital broadcast are recorded in the conventional image storage mediums for domestic use, digital video signals are first decoded and subsequently bandwidth-limited for recording. In the case of the digital recording system, including, of course, the MPEG1 Video, MPEG2 video and DV systems, digital video signals are first decoded and subsequently re-encoded in accordance with an encoding system for the recording rate proper to the apparatus for recording subsequently.

However, this recording system, in which the supplied bitstream is decoded once and subsequently bandwidth-limited and re-encoded prior to recording, suffers from deteriorated picture quality. If, in recording compressed video digital signals, the transmission rate of input digital signals is less than the recording rate for the recording and/or reproducing apparatus, the method of directly recording the supplied bitstream without decoding or re-encoding suffers from deterioration in the picture quality only to the least extent. However, if the transmission rate of the input digital signals exceeds the recording rate of the recording and/or reproducing apparatus, it is indeed necessary to re-encode the bitstream and to record the so-re-encoded bitstream, so that, after decoding in the recording and/or reproducing apparatus, the transmission rate will be not higher than the upper limit of the disc recording rate.

If the bitstream is transmitted in a variable rate system in which the bit rate of the input digital signal is increased or decreased with time, the capacity of the recording medium can be exploited less wastefully in the case of a disc recording

apparatus adapted for transiently storing data in a buffer and for recording the data in a burst fashion than in the case of a tape recording system having a fixed recording rate imposed by the fixed rpm of the rotary head.

Thus, it may be predicted that, in the near future when the digital broadcast is to become the mainstream, an increasing demand will be raised for a recording and/or reproducing apparatus in which broadcast signals are recorded as digital signals, without decoding or re-encoding, as in a data streamer, and in which a disc is used as a recording medium.

By increasing the capacity of the recording medium, a large quantity of data, herein pictures or speech pertinent to programs, can be recorded on the recording medium. So, a large number of programs are recorded on one disc, thereby complicating the operation of the user selecting a desired one of the many programs recorded in the disc. It is therefore necessary for the user to be able to confirm the recorded data in reproducing the disc in a simplified fashion to enable selection of a desired program (data).

#### Disclosure of the Invention

It is therefore an object of the present invention to record the management information of contents of data recorded on a recording medium in the form of a file to enable data contents recorded on a recording medium and the playback information to be supervised appropriately.

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An information processing apparatus according to the present invention includes generating means for generating the playback designation information specifying the sequence of reproducing the information recorded on a recording medium and the management information supervising the playback designation information, and recording means for recording the playback designation information and the management information, generated by the generating means, on the recording medium, wherein the management information contains the name information pertinent to the name assigned to the playback designation information at a time point of completion of playback which is based on the playback designation information, and wherein the playback designation information contains the temporal information on a time point of completion of reproduction which is based on the playback designation information.

An information processing method according to the present invention includes a step of generating the playback designation information specifying the sequence of reproducing the information recorded on a recording medium and the management information supervising the playback designation information, and a step of recording the playback designation information and the management information, generated by the generating means, on the recording medium, wherein the management information contains the name information pertinent to the name assigned to the playback designation information at a time point of completion of playback which is based on the playback designation information, and wherein the playback designation information, and wherein the playback designation

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information contains the temporal information on time point of completion of reproduction which is based on the playback designation information.

In a program according to the present invention, the management information contains the name information pertinent to a name assigned to the playback designation information at a time point of completion of playback which is based on the playback designation information. The playback designation information contains the temporal information on the time point of completion of reproduction which is based on the playback designation information.

In a program for a recording medium, according to the present invention, the management information contains the name information pertinent to a name assigned to the playback designation information at a time point of completion of playback which is based on the playback designation information. The playback designation information contains the temporal information on the time point of completion of reproduction which is based on the playback designation information.

An information processing apparatus according to the present invention includes control means for controlling the playback of the main information on the recording medium based on the management information containing the name information pertinent to a name assigned to the playback designation information at a time point of completion of playback, performed in accordance with the playback designation information, and on the playback designation information containing the temporal information on time point of completion of playback performed in

accordance with the playback designation information.

An information processing method according to the present invention includes a control step of controlling the playback of the main information on the recording medium based on the management information containing the name information pertinent to a name assigned to the playback designation information at a time point of completion of playback, performed in accordance with the playback designation information, and on the playback designation information containing the temporal information on time point of completion of playback performed in accordance with the playback designation information.

A program for a recording medium according to the present invention includes a control step of controlling the playback of the main information on the recording medium based on the management information containing the name information pertinent to a name assigned to the playback designation information at a time point of completion of playback, performed in accordance with the playback designation information, and on the playback designation information containing the temporal information on time point of completion of playback performed in accordance with the playback designation information.

A program according to the present invention is used on a computer controlling an information processing apparatus reproducing the main information from a recording medium having recorded thereon the playback designation information specifying the playback sequence of the main information recorded and the

management information supervising the playback designation information. The program has the computer execute a control step of controlling the playback of the main information on the recording medium based on the management information containing the name information pertinent to a name assigned to the playback designation information at a time point of completion of playback, performed in accordance with the playback designation information, and on the playback designation information containing the temporal information on the time point of completion of playback performed in accordance with the playback designation information.

In a recording medium according to the present invention, the management information contains the name information on a name assigned to the playback designation information at a time point of completion of playback performed in accordance with the playback designation information. The playback designation information contains the temporal information on a time point of completion of playback performed in accordance with the playback designation information.

An information processing apparatus according to the present invention includes generating means for generating the playback designation information specifying the sequence of reproducing the information recorded on a recording medium and the management information supervising the playback designation information, and recording means for recording the playback designation information and the management information, generated by the generating means, on the

recording medium. The management information contains reading permission information pertinent to allowance of reading of the totality of the playback designation information supervised by the management information. The playback designation information contains the reading permission information pertinent to allowance of reading of the playback designation information.

An information processing method according to the present invention includes a generating step of generating the playback designation information specifying the sequence of reproducing the information recorded on a recording medium and the management information supervising the playback designation information, and a recording step of recording the playback designation information and the management information, generated by the generating step, on the recording medium. The management information contains reading permission information pertinent to allowance of reading of the totality of the playback designation information supervised by the management information. The playback designation information contains the reading permission information pertinent to allowance of reading of the playback designation information.

In a program for a recording medium according to the present invention, the management information contains reading permission information pertinent to allowance of reading of the totality of the playback designation information supervised by the management information. The playback designation information contains the reading permission information pertinent to allowance of reading of the

playback designation information.

In a program according to the present invention, the management information contains reading permission information pertinent to allowance of reading of the totality of the playback designation information supervised by the management information. The playback designation information contains the reading permission information pertinent to allowance of reading of the playback designation information.

In a recording medium according to the present invention, the management information contains reading permission information pertinent to allowance of reading of the totality of the playback designation information supervised by the management information. The playback designation information contains the reading permission information pertinent to allowance of reading of the playback designation information.

An information processing apparatus according to the present invention includes generating means for generating the playback designation information specifying the sequence of reproducing the information recorded on a recording medium and the management information supervising the playback designation information, and recording means for recording the management information generated by the generating means on the recording medium. The management information contains the playback sequence information for registering, in the playback sequence, the totality of the playback designation information supervised by the management information. The playback sequence information contains the temporal information for its playback domains.

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An information processing method according to the present invention includes a generating step of generating the playback designation information specifying the sequence of reproducing the information recorded on a recording medium and the management information supervising the playback designation information and a recording step of recording the management information generated by the generating means on the recording medium. The management information contains the playback sequence information for registering, in the playback sequence, the totality of the playback designation information supervised by the management information. The playback sequence information contains the temporal information for its playback domains.

In a program for a recording medium according to the present invention, the management information contains the playback sequence information for registering, in the playback sequence, the totality of the playback designation information supervised by the management information. The playback sequence information contains the temporal information for its playback domains.

In a program according to the present invention, the management information contains the playback sequence information for registering, in the playback sequence, the totality of the playback designation information supervised by the management information. The playback sequence information contains the temporal information for its playback domains.

An information processing apparatus according to the present invention includes

control means for controlling the playback of the main information of the recording medium based on the management information including the playback designation information registering, in the playback sequence, the totality of the playback designation information supervised by the management information, and on the playback designation information containing the temporal information for its playback domains.

An information processing method according to the present invention includes a control step of controlling the playback of the main information of the recording medium based on the management information including the playback designation information registering, in the playback sequence, the totality of the playback designation information supervised by the management information, and on the playback designation information containing the temporal information for its playback domains.

A program for a recording medium according to the present invention includes a control step of controlling the playback of the main information of the recording medium based on the management information including the playback designation information registering, in the playback sequence, the totality of the playback designation information supervised by the management information, and on the playback designation information containing the temporal information for its playback domains.

A program according to the present invention is used in a computer controlling

an information processing apparatus reproducing the main information from a recording medium having recorded thereon the playback designation information specifying the playback sequence of the main information recorded and the management information for supervising the playback designation information, and has the computer execute a control step controlling the playback of the main information of the recording medium based on the management information including the playback designation information registering, in the playback sequence, the totality of the playback designation information supervised by the management information, and on the playback designation information containing the temporal information for its playback domains.

In a recording medium according to the present invention, the management information contains the playback sequence information for registering, in the playback sequence, the totality of the playback designation information supervised by the management information. The playback designation information contains the temporal information for its playback domains.

In the information processing method and apparatus, recording medium, program, second information processing method and apparatus, recording medium and the program, according to the present invention, the management information includes the name information pertinent to a name assigned to the playback designation information at a time point of completion of playback, performed in accordance with the playback designation information, with the playback designation information

containing the temporal information on the time point of completion of playback, performed in accordance with the playback designation information.

In the information processing method and apparatus, recording medium, program, fourth information processing method and apparatus, recording medium and the program, according to the present invention, the management information contains reading permission information pertinent to allowance of reading of the totality of the playback designation information supervised by the management information, with the playback designation information containing the reading permission information pertinent to allowance of reading of the playback designation information.

With information processing method and apparatus, recording medium and the program, according to the present invention, the management information contains the playback sequence information registering, in the playback sequence, the totality of the playback designation information supervised by the management information, with the playback designation information containing the temporal information for its playback domains.

Other objects, features and advantages of the present invention will become more apparent from reading the embodiments of the present invention as shown in the drawings.

#### **Brief Description of the Drawings**

Fig.1 shows a configuration of an embodiment of a recording and/or

reproducing apparatus according to the present invention.

Fig.2 illustrates the data format of data recorded on a recording medium by a recording and/or reproducing apparatus 1.

Fig.3 illustrates Real PlayList and Virtual PlayList.

Figs.4A, 4B and 4C illustrate the creation of the Real PlayList.

Figs.5A, 5B and 5C illustrate deletion of the Real PlayList.

Figs.6A and 6B illustrate assemble editing.

Fig.7 illustrates provision of a sub path in the Virtual PlayList.

Fig.8 illustrates the changing of the playback sequence of the PlayList.

Fig.9 illustrates a mark on the PlayList and a mark on the Clip.

Fig.10 illustrates a menu thumbnail.

Fig.11 illustrates mark added to the PlayList.

Fig.12 illustrates a mark added to the Clip.

Fig.13 illustrates the relation between the PlayList, Clip and the thumbnail file.

Fig.14 illustrates a directory structure.

Fig.15 illustrates a syntax of `infr.dvr`.

Fig.16 shows a syntax of DVRVolume.

Fig.17 shows a syntax of ResumeVolume.

Fig.18 shows a syntax of UIAppInfoVolume.

Fig.19 shows a table of character set values.

Fig.20 shows a syntax of TableOfPlayList.

Fig.21 shows another syntax of TableOfPlayList.

Fig.22 shows a syntax of the MakersPrivateData.

Fig.23 shows a syntax of xxxx.rpls and yyyy.vpls.

Figs.24A to 24C illustrate the Playlist.

Fig.25 shows a syntax of Playlist.

Fig.26 shows a table of Playlist\_type.

Fig.27 shows a syntax of UIAppInfoPlaylist.

Figs.28A to 28C illustrate flags in the UIAppInfoPlaylist syntax shown in

Fig.27.

Fig.29 illustrates a PlayItem.

Fig.30 illustrates a PlayItem.

Fig.31 illustrates a PlayItem.

Fig.32 shows a syntax of the PlayItem.

Fig.33 illustrates IN-time.

Fig.34 illustrates OUT-time.

Fig.35 shows a table of Connection\_Condition.

Figs.36A to 36D illustrate Connection\_Condition.

Fig.37 illustrates BridgeSequenceInfo.

Fig.38 shows a syntax of BridgeSequenceInfo.

Fig.39 illustrates SubPlayItem.

Fig.40 shows a syntax of SubPlayItem.

Fig.41 shows a table of `Mark_type`.

Fig.42 shows a syntax of `PlayListMark`.

Fig.43 shows a table of `Mark_type`.

Fig.44 illustrates `Mark_time_stamp`.

Fig.45 shows a syntax of `zzzzz.clip`.

Fig.46 shows a syntax of `ClipInfo`.

Fig.47 shows a table of `Clip_stream_type`.

Fig.48 illustrates `offset_SPN`.

Fig.49 illustrates `offset_SPN`.

Figs.50A, 50B illustrate the STC domain.

Fig.51 illustrates `STC_Info`.

Fig.52 shows a syntax of `STC_Info`.

Fig.53 illustrates `ProgramInfo`.

Fig.54 shows a syntax of `ProgramInfo`.

Fig.55 shows a syntax of `VideoCodingInfo`.

Fig.56 shows a table of `Video_format`.

Fig.57 shows a table of `frame_rate`.

Fig.58 shows a table of `display_aspect_ratio`.

Fig.59 shows a syntax of `AudioCodingInfo`.

Fig.60 shows a table of `audio_coding`.

Fig.61 shows a table of `audio_component_type`.

Fig.62 shows a table of sampling\_frequency.

Fig.63 illustrates CPI.

Fig.64 illustrates CPI.

Fig.65 shows a syntax of CPI.

Fig.66 shows a table of CPI\_type.

Fig.67 illustrates video EP\_map.

Fig.68 illustrates EP\_map.

Fig.69 illustrates EP\_map.

Fig.70 shows a syntax of EP\_map.

Fig.71 shows a table of EP\_typevalues.

Fig.72 shows a syntax of EP\_map\_for\_one\_stream\_PID.

Fig.73 illustrates TU\_map.

Fig.74 shows a syntax of TU\_map.

Fig.75 shows a syntax of ClipMark.

Fig.76 shows a table of Mark\_type.

Fig.77 shows a table of Mark\_type\_stamp.

Fig.78 shows a syntax of menu.thmb and mark.thmb.

Fig.79 shows the syntax of thumbnail.

Fig.80 shows a table of thumbnail\_picture\_format.

Figs.81A and 81B illustrate tn\_block.

Fig.82 illustrates a structure of a transport stream of DVR MPEG2.

Fig.83 shows a recorder model of a transport stream of DVR MPEG2.

Fig.84 shows a player model of a transport stream of DVR MPEG2.

Fig.85 shows the syntax of a source packet.

Fig.86 shows the syntax of `TP_extra_header`.

Fig.87 shows a table of a copy permission indicator.

Fig.88 illustrates seamless connection.

Fig.89 illustrates seamless connection.

Fig.90 illustrates seamless connection.

Fig.91 illustrates seamless connection.

Fig.92 illustrates seamless connection.

Fig.93 illustrates audio overlap.

Fig.94 illustrates seamless connection employing BridgeSequence.

Fig.95 illustrates seamless connection not employing BridgeSequence.

Fig.96 shows a DVR STD model.

Fig.97 is a timing chart for decoding and display.

Fig.98 is a flowchart for illustrating the processing for creating/updating

info.dvr.

Fig.99 is a flowchart for illustrating the processing for reproducing the PlayList.

Fig.100 is a flowchart for modifying the playback sequence of the PlayList.

Fig.101 illustrates a medium.

## Best Mode for Carrying out the Invention

Referring to the drawings, present embodiment of the present invention will be explained in detail. Fig.1 shows a typical inner structure of a recording and/or reproducing apparatus 1 embodying the present invention. First, the structure of a recording unit 2, configured for recording signals input from outside, is explained. The recording and/or reproducing apparatus 1 is configured for being fed with and recording analog or digital data.

Analog video signals and analog audio signals are fed to terminals 11, 12, respectively. The video signals, input to the terminal 11, are output to an analysis unit 14 and to an AV encoder 15. The audio signals, input to the terminal 12, are output to the analysis unit 14 and to the AV encoder 15. The analysis unit 14 extracts feature points, such as scene changes, from the input video and audio signals.

The AV encoder 15 encodes input video and audio signal to output the system information (S), such as an encoded video stream (V), an encoded audio stream (A) and AV synchronization, to a multiplexer 16.

The encoded video stream is a video stream encoded e.g., with the MPEG (Moving Picture Expert Group) 2 system, whilst the encoded audio stream is an audio stream encoded in accordance with the MPEG1 system, with the encoded audio stream being e.g., an audio stream encoded in e.g., the MPEG1 system or an audio stream encoded in accordance with the Dolby AC3 (trademark) system. The multiplexer 16 multiplexes the input video and audio streams, based on the input system information,

to output a multiplexed stream through a switch 17 to a multiplexed stream analysis unit 18 and to a source packetizer 19.

The multiplexed stream is e.g., an MPEG-2 transport stream or an MPEG2 program stream. The source packetizer 19 encodes the input multiplexed stream into an AV stream composed of source packets in accordance with an application format of a recording medium 100 on which to record the stream. The AV stream is processed in ECC (error correction and coding) unit 20 and a modulation unit 21 with appendage of ECC codes and with modulation, before being output to a write unit 22, which then writes (records) an AV stream file based on a control signals output by the controller 23.

The transport stream, such as digital television broadcast, input from a digital interface or a digital television tuner, is input to a terminal 13. There are two recording systems for recording the transport stream input to the terminal 13, one being a transparent recording system and the other being a system in which recording is preceded by re-encoding aimed to lower e.g., the recording bit rate. The recording system command information is input from a terminal 24 as a user interface to a controller 23.

In the transparent recording of the input transport stream, a transport stream, input to a terminal 13, is output through a switch 17 to a multiplexed stream analysis unit 18 and to the source packetizer 19. The ensuing processing of recording an AV stream on a recording medium is the same as that of encoding and recording analog

input audio and video signals, as described above, and hence is not explained here for simplicity.

If the input transport stream is re-encoded and subsequently recorded, the transport stream, input to the terminal 13, is fed to a demultiplexer 26, which demultiplexes the input transport stream to extract a video stream (V), an audio stream (A) and the system information (S).

Of the stream (information), as extracted by the demultiplexer 26, the video stream is output to an audio decoder 27, whilst the audio stream and the system information are output to the multiplexer 16. The audio decoder 27 decodes the input transport stream to output the encoded video stream (V) to the multiplexer 16.

The audio stream and the system information, output from the demultiplexer 26 and input to the multiplexer 16, and the video stream, output by the AV encoder 15, are multiplexed, based on the input system information, and output to the multiplexed stream analysis unit 18 and to the source packetizer 19 through switch 17, as a multiplexed stream. The ensuing processing of recording an AV stream on a recording medium is the same as that of encoding and recording analog input audio and video signals, as described above, and hence is not explained here for simplicity.

The recording and/or reproducing apparatus 1 of the present embodiment records a file of the AV stream on the recording medium 100, while also recording the application database information which accounts for the file. The input information to the controller 23 is the feature information for the moving picture from the analysis

unit 14, the feature information of the AV stream from the multiplexed stream analysis unit 18 and the user command information input at a terminal 24.

The feature information of the moving picture, supplied from the analysis unit 14, is generated by the analysis unit 14 when the AV encoder 15 encodes video signals. The analysis unit 14 analyzes the contents of the input video and audio signals to generate the information pertinent to the pictures characteristic of the input moving picture signals (clip mark). This information is the information indicating a picture of characteristic clip mark points, such as program start points, scene change points, CM commercial start and end points, title or telop in input video signals, and also includes a thumbnail of the picture and the information pertinent to stereo/monaural switching points and muted portions of audio signals.

The above picture indicating information is fed through controller 23 to the multiplexer 16. When multiplexing a encoded picture specified as clip mark by the controller 23, the multiplexer 16 returns the information for specifying the encoded picture on the AV stream to the controller 23. Specifically, this information is the PTS (presentation time stamp) of a picture or the address information on the AV stream of an encoded version of the picture. The controller 23 stores the sort of feature pictures and the information for specifying the encoded picture on the AV stream in association with each other.

The feature information of the AV stream from the multiplexed stream analysis unit 18 is the information pertinent to the encoding information of the AV stream to

be recorded, and is recorded by an analysis unit 18. For example, the feature information includes the time stamp and address information of the I-picture in the AV stream, discontinuous point information of system time clocks, encoding parameters of the AV stream and change point information of the encoding parameters in the AV stream. When transparently recording the transport stream, input from the terminal 13, the multiplexed stream analysis unit 18 detects the picture of the aforementioned clip mark, from the input transport stream, and generates the information for specifying a picture designated by the clip mark and its type.

The user designation information from the terminal 24 is the information specifying the playback domain, designated by the user, character letters for explaining the contents of the playback domain, or the information such as bookmarks or resuming points set by the user for his or her favorite scene.

Based on the aforementioned input information, the controller 23 creates a database of the AV stream (Clip), a database of a group (PlayList) of playback domains (PlayItem) of the AV stream, management information of the recorded contents of the recording medium 100 (info.dvr) and the information on thumbnail pictures. Similarly to the AV stream, the application database information, constructed from the above information, is processed in the ECC unit 20 and the modulation unit 21 and input to the write unit 22, which then records a database file on the recording medium 100.

The above-described application database information will be explained

subsequently in detail.

When the AV stream file recorded on the recording medium 100 (files of picture data and speech data) and the application database information, thus recorded on the recording medium 100, are reproduced by a reproducing unit 3, the controller 23 first commands a readout unit 28 to read out the application database information from the recording medium 100. The readout unit 28 reads out the application database information from the recording medium 100, which then reads out the application database information from the recording medium 100 to send the application database information through demodulation and error correction processing by a demodulating unit 29 and an ECC decoder 30 to the controller 23.

Based on the application database information, the controller 23 outputs a list of PlayList recorded on the recording medium 100 to a user interface of the terminal 24. The user selects the PlayList, desired to be reproduced, from the list of PlayLists. The information pertinent to PlayList, specified to be reproduced, is input to the controller 23. The controller 23 commands the readout unit 28 to read out the AV stream file necessary in reproducing the PlayList. In accordance with the command, the readout unit 28 reads out the corresponding AV stream from the recording medium 100 to output the read-out AV stream to the demodulating unit 29. The AV stream, thus input to the demodulating unit 29, is demodulated by preset processing and output through the processing by the ECC decoder 30 to a source depacketizer 31.

The source depacketizer 31 converts the AV stream of the application format,

read out from the recording medium 100 and processed in a preset fashion, into a stream processable by the demultiplexer 26. The demultiplexer 26 outputs the system information (S), such as the video stream (V), audio stream (A) or the AV synchronization, forming the playback domain (PlayItem) of the AV stream specified by the controller 23, to the audio decoder 27, which AV decoder 27 decodes the video stream and the audio stream to output the playback video signal and the playback audio signal to associated terminals 32, 33, respectively.

If fed from the terminal 24, as a user interface, with the information instructing random access playback or special playback, the controller 23 determines the readout position of the AV stream from the recording medium 100, based on the contents of the database (Clip) of the AV stream, to command the readout unit 28 to read out the AV stream. If the PlayList as selected by the user is to be reproduced as from a preset time point, the controller 23 commands the readout unit 28 to read out data from an I-picture having a time stamp closest to the specified time point.

When the user has selected a certain clip mark from indexing points or scene change points for the program stored in the ClipMark in the Clip Information, as when the user selects a certain picture from a list of thumbnail pictures, as demonstrated on a user interface, of the indexing points or scene change points stored in the ClipMark, the controller 23 determines the AV stream readout position from the recording medium 100 to command the readout unit 28 to read out the AV stream. That is, the controller 23 commands the readout unit 28 to read out data from an I-picture having

an address closest to the address on the AV stream which has stored the picture selected by the user. The readout unit 28 reads out data from the specified address. The read-out data is processed by the demodulating unit 29, ECC decoder 30 and by the source packetizer 19 so as to be supplied to the demultiplexer 26 and decoded by the audio decoder 27 to reproduce AV data indicated by an address of the mark point picture.

If the user has commanded fast forward playback, the controller 23 commands the readout unit 28 to sequentially read out I-picture data in the AV stream in succession based on the database (Clip) of the AV stream.

The readout unit 28 reads out data of the AV stream from a specified random access point. The so read-out data is reproduced through processing by various components on the downstream side.

The case in which the user edits the AV stream recorded on the recording medium 100 is now explained. If desired to specify a playback domain for the AV stream recorded on the recording medium 100, for example, if desired to create a playback route of reproducing a portion sung by a singer A from a song program A, and subsequently reproducing a portion sung by the same singer A from another song program B, the information pertinent to a beginning point (IN-point) and an end point (OUT-point) of the playback domain is input to the controller 23 from the terminal as a user interface. The controller 23 creates a database of the group (PlayList) of playback domains (PlayItem) of the AV streams.

When the user desires to erase a portion of the AV stream recorded on the recording medium 100, the information pertinent to the IN-point and the OUT-point of the erasure domain is input to the controller 23, which then modifies the database of the PlayList so as to refer to only the needed AV streams. The controller 23 also commands the write unit 22 to erase an unneeded stream portion of the AV stream.

The case in which the user desires to specify playback domains of an AV stream recorded on the recording medium to create a new playback route, and to interconnect the respective playback domains in a seamless fashion, is now explained. In such case, the controller 23 creates a database of a group (PlayList) of the playback domains (PlayItem) of the AV stream and undertakes to partially re-encode and re-multiplex the video stream in the vicinity of junction points of the playback domains.

The picture information at the IN-point and that at the OUT-point of a playback domain are input from a terminal 24 to a controller 23. The controller 23 commands the readout unit 28 to read out data needed to reproduce the pictures at the IN-point and at the OUT-point. The readout unit 28 reads out data from the recording medium 100. The data so read out is output through the demodulating unit 29, ECC decoder 30 and the source packetizer 19 to the demultiplexer 26.

The controller 23 analyzes data input to the demultiplexer 26 to determine the re-encoding method for the video stream (change of picture\_coding\_type and assignment of the quantity of encoding bits for re-encoding) and the re-multiplexing system to send the system to the AV encoder 15 and to the multiplexer 16.

The demultiplexer 26 then separates the input stream into the video stream (V), audio stream (A) and the system information (S). The video stream may be classed into data input to the audio decoder 27 and data input to the multiplexer 16. The former is data needed for re-encoding, and is decoded by the audio decoder 27, with the decoded picture being then re-encoded by the AV encoder 15 and thereby caused to become a video stream. The latter data is data copied from an original stream without re-encoding. The audio stream and the system information are directly input to the multiplexer 16.

The multiplexer 16 multiplexes an input stream, based on the information input from the controller 23, to output a multiplexed stream, which is processed by the ECC unit 20 and the modulation unit 21 so as to be sent to the write unit 22. The write unit 22 records an AV stream on the recording medium 100 based on the control signals supplied from the controller 23.

The application database information and the operation based on this information, such as playback and editing, are hereinafter explained. Fig.2 shows the structure of an application format having two layers, that is PlayList and Clip, for AV stream management. The Volume Information manages all Clips and PlayLists in the disc. Here, one AV stream and the ancillary information thereof, paired together, is deemed to be an object, and is termed Clip. The AV stream file is termed a Clip AV stream file, with the ancillary information being termed the Clip Information file.

One Clip AV stream file stores data corresponding to an MPEG-2 transport

stream arranged in a structure prescribed by the application format. By and large, a file is treated as a byte string. The contents of the Clip AV stream file are expanded on the time axis, with entry points in the Clip (I-picture) being mainly specified on the time basis. When a time stamp of an access point to a preset Clip is given, the Clip Information file is useful in finding the address information at which to start data readout in the Clip AV stream file.

Referring to Fig.3, PlayList is now explained, which is provided for a user to select a playback domain desired to be viewed from the Clip and to edit the playback domain readily. One PlayList is a set of playback domains in the Clip. One playback domain in a preset Clip is termed PlayItem and is represented by a pair of an IN-point and an OUT-point on the time axis. So, the PlayList is formed by a set of plural PlayItems.

The PlayList is classified into two types, one of which is Real PlayList and the other of which is Virtual PlayList. The Real PlayList co-owns stream portions of the Clip it is referencing. That is, the Real PlayList takes up in the disc the data capacity corresponding to a stream portion of the Clip it is referencing and, when Real PlayList is erased, the data of the stream portion of the Clip it is referencing is also erased.

The Virtual PlayList is not co-owning Clip data. Therefore, if the Virtual PlayList is changed or erased, the contents of the Clip are in no way changed.

The editing of the Real Playlist is explained. Fig.4A shows creation of Real Playlist and, if the AV stream is recorded as a new Clip, the Real Playlist which

references the entire Clip is a newly created operation.

Fig.4B shows the division of the real PlayList, that is the operation of dividing the Real PlayList at a desired point to split the Real PlayList in two Real PlayLists. This division operation is performed when two programs are managed in one clip managed by a sole PlayList and when the user intends to re-register or re-record the programs as separate individual programs. This operation does not lead to alteration of the Clip contents, that is to division of the Clip itself.

Fig.4C shows the combining operation of the Real PlayList which is the operation of combining two Real PlayLists into one new Real PlayList. This combining operation is performed such as when the user desires to re-register two programs as a sole program. This operation does not lead to alteration of the Clip contents, that is to combining the clip itself into one.

Fig.5A shows deletion of the entire Real PlayList. If the operation of erasing the entire preset Real PlayList, the associated stream portion of the Clip referenced by the deleted Real PlayList is also deleted.

Fig.5B shows partial deletion of the Real PlayList. If a desired portion of the Real PlayList is deleted, the associated PlayItem is altered to reference only the needed Clip stream portion. The corresponding stream portion of the Clip is deleted.

Fig.5C shows the minimizing of the Real PlayList. It is an operation of causing the PlayItem associated with the Real PlayList to reference only the stream portion of the Clip needed for Virtual PlayList. The corresponding stream portion of the Clip not

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needed for the Virtual PlayList is deleted.

If the Real PlayList is changed by the above-described operation such that the stream portion of the Clip referenced by the Real PlayList is deleted, there is a possibility that the Virtual PlayList employing the deleted Clip is present such that problems may be produced in the Virtual PlayList due to the deleted Clip.

In order to prevent this from occurring, such a message which runs: "If there exists the Virtual PlayList referencing the stream portion of the Clip the Real PlayList is referencing, and the Real PlayList is deleted, the Virtual PlayList itself is deleted – is it all right?" is displayed for the user in response to the user's operation of deletion by way of confirmation or alarming, after which the processing for deletion is executed or cancelled subject to user's commands. Alternatively, the minimizing operation for the Real PlayList is performed in place of deleting the Virtual PlayList.

The operation for the Virtual PlayList is now explained. If an operation is performed for the Virtual PlayList, the contents of the Clip are not changed. Figs.6A and 6B show the assembling and editing (IN-OUT editing). It is an operation of creating PlayItem of the playback domain the user has desired to view to create Virtual PlayList. The seamless connection between PlayItems is supported by the application format, as later explained.

If there exist two Real PlayLists 1, 2 and clips 1, 2 associated with the respective Real PlayLists, the user specifies a preset domain in the Real PlayList 1 (domain from IN1 to OUT1: PlayItem 1) as the playback domain, and also specifies,

as the domain to be reproduced next, a preset domain in the Real PlayList 2 (domain from IN2 to OUT2: PlayItem 2) as the playback domain, as shown in Fig.6A, a sole Virtual PlayList made up of PlayItem 1 and the PlayItem2 is prepared, as shown in Fig.6B.

The re-editing of the Virtual PlayList is now explained. The re-editing may be enumerated by alteration of IN- or OUT points in the Virtual PlayList, insertion or appendage of new PlayItems to the Virtual PlayList and deletion of PlayItems in the Virtual PlayList. The Virtual PlayList itself may also be deleted.

Fig.7 shows the audio dubbing (post recording) to the Virtual PlayList. It is an operation of registering the audio post recording to the Virtual PlayList as a sub path. This audio post recording is supported by the application software. An additional audio stream is added as a sub path to the AV stream of the main path of the Virtual PlayList.

Common to the Real PlayList and the Virtual PlayList is an operation of changing (moving) the playback sequence of the PlayList shown in Fig.8. This operation is an alteration of the playback sequence of the PlayList in the disc (volume) and is supported by TableOfPlayList as defined in the application format, as will be explained subsequently with reference to e.g., Fig.20. This operation does not lead to alteration of the Clip contents.

The mark (Mark) is now explained. The mark is provided for specifying a highlight or characteristic time in the Clip and in the PlayList, as shown in Fig.9. The

mark added to the Clip is termed the ClipMark. The ClipMark is e.g., a program indexing point or a scene change point for specifying a characteristic scene ascribable to contents in the AV stream. The ClipMark is generated by e.g., the analysis unit 14 of Fig.1. When the PlayList is reproduced, the mark of the Clip referenced by the PlayList may be referenced and used.

The mark appended to the PlayList is termed the PlayListMark (play list mark). The PlayListMark is e.g., a bookmark point or a resuming point as set by the user. The setting of the mark to the Clip and to the PlayList is by adding a time stamp indicating the mark time point to the mark list. On the other hand, mark deletion is removing the time stamp of the mark from the mark list. Consequently, the AV stream is in no way changed by mark setting or by mark deletion.

As another format of the ClipMark, a picture referenced by the ClipMark may be specified on the address basis in the AV stream. Mark setting on the Clip is by adding the address basis information indicating the picture of the mark point to the mark list. On the other hand, mark deletion is removing the address basis information indicating the mark point picture from the mark list. Consequently, the AV stream is in no way changed by mark setting or by mark deletion.

A thumbnail is now explained. The thumbnail is a still picture added to the Volume, PlayList and Clip. There are two sorts of the thumbnail, one of them being a thumbnail as a representative picture indicating the contents. This is mainly used in a main picture in order for the user to select what he or she desired to view on

acting on a cursor, not shown. Another sort of the thumbnail is a picture indicating a scene pointed by the mark.

The Volume and the respective PlayLists need to own representative pictures. The representative pictures of the Volume are presupposed to be used for initially demonstrating a still picture representing the disc contents when the disc is set in position in the recording and/or reproducing apparatus 1. It is noted that the disc means the recording medium 100 which is presupposed to be a of disc shape. The representative picture of the Playlist is presupposed to be used as a still picture for representing Playlist contents.

As the representative picture of the Playlist, it may be contemplated to use the initial picture of the Playlist as the thumbnail (representative picture). However, the leading picture at the playback time of 0 is not necessarily an optimum picture representing the contents. So, the user is allowed to set an optional picture as a thumbnail of the Playlist. Two sorts of the thumbnails, that is the thumbnail as a representative picture indicating the Volume and the thumbnail as a representative picture indicating Playlist, are termed menu thumbnails. Since the menu thumbnails are demonstrated frequently, these thumbnails need to be read out at an elevated speed from the disc. Thus, it is efficient to store the totality of the menu thumbnails in a sole file. It is unnecessary for the menu thumbnails to be pictures extracted from the moving pictures in the volume, but may be a picture captured from a personal computer or a digital still camera, as shown in Fig.10.

On the other hand, the Clip and the PlayList need be marked with plural marks, whilst the pictures of the mark points need to be readily viewed in order to grasp the contents of the mark positions. The picture indicating such mark point is termed a mark thumbnail. Therefore, the picture which is the original of the mark thumbnail is mainly an extracted mark point picture rather than a picture captured from outside.

Fig.11 shows the relation between the mark affixed to the PlayList and the mark thumbnail, whilst Fig.12 shows the relation between the mark affixed to the Clip and the mark thumbnail. In distinction from the menu thumbnail, the mark thumbnail is used in e.g., a sub-menu for representing details of the PlayList, while it is not requested to be read out in a short access time. So, whenever a thumbnail is required, the recording and/or reproducing apparatus 1 opens a file and reads out a portion of the file, while there is no problem presented even if file opening and reading out a portion of the file by the recording and/or reproducing apparatus 1 takes some time.

For decreasing the number of files present in a volume, it is preferred for the totality of the mark thumbnails to be stored in one file. While the PlayList may own one menu thumbnail and plural mark thumbnails, the user is not required to select the Clip directly (usually, the Clip is selected through PlayList), and hence there is no necessity of providing menu thumbnails.

Fig.13 shows the relation between the menu thumbnails, mark thumbnails, PlayList and Clips. In the menu thumbnail file are filed menu thumbnails provided from one PlayList to another. In the menu thumbnail file is contained a volume

thumbnail representing the contents of data recorded on the disc. In the menu thumbnail file are filed thumbnails created from one PlayList to another and from one Clip to another.

The CPI (Characteristic Point Information) is hereinafter explained. The CPI is data contained in the Clip information file and is used mainly for finding a data address in the Clip AV stream file at which to start the data readout when a time stamp of the access point to the Clip is afforded. In the present embodiment two sorts of the CPI are used, one of them being EP\_map and the other being TU\_map.

The EP\_map is a list of entry point (EP) data extracted from the elementary stream and the transport stream. This has the address information used to find the site of entry points in the AV stream at which to start the decoding. One EP data is made up of a presentation time stamp (PTS) and a data address in the AV stream of the accessing unit associated with the PTS, with the data address being paired to the PTS.

The EP\_map is used mainly for two purposes. First, it is used for finding a data address in the AV stream in the accessing unit referenced by the PTS in the PlayList. Second, the EP\_map is used for fast forward playback or fast reverse playback. If, in recording the input AV stream by the recording and/or reproducing apparatus 1, the syntax of the stream can be analyzed, the EP\_map is created and recorded on the disc.

The TU\_map has a list of time unit (TU) data which is derived from the arrival time point of the transport packet input through a digital interface. This affords the relation between the arrival-time-based time and the data address in the AV stream.

When the recording and/or reproducing apparatus 1 records an input AV stream, and the syntax of the stream cannot be analyzed, a TU\_map is created and recorded on the disc.

The STCInfo stores the discontinuous point information in the AV stream file which stores the MPEG-2 transport stream.

When the AV stream has discontinuous points of STC, the same PTS values may appear in the AV stream file. Thus, if a time point in the AV stream is specified on the PTS basis, the PTS pf the access point is insufficient to specify the point. Moreover, an index of the continuous STC domain containing the PTS is required. In this format, the continuous STC domain and its index are termed an STC-sequence and STC-sequence-id, respectively. The STC-sequence information is defined by the STCInfo of the Clip Information file.

The STC-sequence-id is used in an AV stream file and is optional in the AV stream file having the TU\_map.

The programs are each a collection of elementary streams and co-own a sole system time base for synchronized reproduction of these streams.

It is useful for a reproducing apparatus (recording and/or reproducing apparatus 1 of Fig.1) to know the contents of an AV stream prior to its decoding. These contents include e.g., values of the PID of a transport packet transmitting an audio or video elementary stream or the type of the video or audio components, such as HDTV video or MPEG-2 AAC audio stream. This information is useful for creating a menu screen

for illustrating to the user the contents of the PlayList referencing the AV stream. It is similarly useful for setting the initial state of the AV decoder and the demultiplexer of the respective apparatus.

For this reason, the Clip Information file owns ProgramInfo for illustrating the program contents.

It may be an occurrence that program contents be changed in the AV stream file in which the MPEG-2 transport stream is stored. For example, the PID of the transport packet transmitting the video elementary stream may be changed, or the component type of the video stream may be changed from SDTV to HDTV.

The ProgramInfo stores the information on change points of program contents in the AV stream file. The domain of the AV stream file in which the program contents remain constant is termed program-sequence.

This program-sequence is used in an AV stream file having EP\_map and is optional in an AV stream file having TU\_map.

The present embodiment defines the self-encoding stream format (SESF). The SESF is used for encoding analog input signals and for decoding digital input signals for subsequently encoding the decoded signal into an MPEG-2 transport stream.

The SESF defines an elementary stream pertinent to the MPEG-2 transport stream and the AV stream. When the recording and/or reproducing apparatus 1 encodes and records input signals in the SESF, an EP\_map is created and recorded on the disc.

A digital broadcast stream uses one of the following systems for recording on

the recording medium 100: First, the digital broadcast stream is transcoded into an SESF stream. In this case, the recorded stream must conform to SESF and EP\_map must be prepared and recorded on the disc.

Alternatively, an elementary stream forming a digital broadcast stream is transcoded to a new elementary stream and re-multiplexed to a new transport stream conforming to the stream format prescribed by the organization for standardizing the digital broadcast stream. In this case, an EP\_map must be created and recorded on the disc.

For example, it is assumed that the input stream is an MPEG-2 transport stream conforming to the ISDB (standard appellation of digital BS of Japan), with the transport stream containing the HDTV video stream and the MPEG AAC audio stream. The HDTV video stream is transcoded to an SDTV video stream, which SDTV video stream and the original AAC audio stream are re-multiplexed to TS. The SDTV stream and the transport stream both need to conform to the ISDB format.

Another system of recording the digital broadcast stream on the recording medium 100 is to make transparent recording of the input transport stream, that is to record the input transport stream unchanged, in which case the EP\_map is formulated and recorded on the disc.

Alternatively, the input transport stream is recorded transparently, that is an input transport stream is recorded unchanged, in which case TU\_map is created and recorded on the disc.

The directory and the file are hereinafter explained. The recording and/or reproducing apparatus 1 is hereinafter described as DVR (digital video recording). Fig.14 shows a typical directory structure on the disc. The directories of the disc of the DVR may be enumerated by a root directory including "DVR" directory, and the "DVR" directory, including "PLAYLIST" directory, "CLIPINF" directory, "M2TS" directory and "DATA" directory, as shown in Fig.14. Although directories other than these may be created below the root directory, these are discounted in the application format of the present embodiment.

Below the "DATA" directory, there are stored all files and directories prescribed by the DVR application format. The "DVR" directory includes four directories. Below the "PLAYLIST" directory are placed Real PlayList and Virtual PlayList database files. The latter directory may exist in a state devoid of PlayList.

Below "CLIPINF" is placed a Clip database. This directory, too, may exist in a state devoid of AV stream files. In the "DATA" directory, there are stored files of data broadcast, such as digital TV broadcast.

The "DVR" directory stores the following files: That is, an "info.dvr" is created below the DVR directory to store the comprehensive information of an application layer. Below the DVR directory, there must be a sole info.dvr. The filename is assumed to be fixed to info.dvr. The "menu.thmb" stores the information pertinent to the menu thumbnails. Below the DVR directory, there must be 0 or 1 mark thumbnail. The filename is assumed to be fixed to "menu.thmb". If there is no menu thumbnail,

this file may not exist.

The “mark.thmb” file stores the information pertinent to the mark thumbnail picture. Below the DVR directory, there must be 0 or 1 mark thumbnail. The filename is assumed to be fixed to “menu.thmb”. If there is no menu thumbnail, this file may not exist.

The “PLAYLIST” directory stores two sorts of the PlayList files which are Real PlayList and Virtual PlayList. An “xxxxx.rpls” file stores the information pertinent to one Real PlayList. One file is created for each Real PlayList. The filename is “xxxxx.rpls”, where “xxxxx” denotes five numerical figures from 0 to 9. A file extender must be “rpls”.

The “yyyyy.vpls” stores the information pertinent to one Virtual PlayList. One file with a filename “yyyyy,vpls” is created from one Virtual PlayList to another, where “yyyyy” denotes five numerical figures from 0 to 9. A file extender must be “vpls”.

The “CLIPINF” directory stores one file in association with each AV stream file. The “zzzzz.clpi” is a Clip Information file corresponding to one AV stream file (Clip AV stream file or Bridge-Clip stream file). The filename is “zzzzz.clpi”, where “zzzzz” denotes five numerical figures from 0 to 9. A file extender must be “clpi”.

The “M2TS” directory stores an AV stream file. The “zzzzz.m2ts” file is an AV stream file handled by the DVR system. This is a Clip AV stream file or a Bridge-Clip AV stream file. The filename is “zzzzz.m2ts”, where “zzzzz” denotes five numerical figures from 0 to 9. A file extender must be “m2ts”.

The "DATA" directory stores data transmitted from data broadcasting. This data may, for example, be XML or MPEG files.

The syntax and the semantics of each directory (file) are now explained. Fig.15 shows the syntax of the "info.dvr" file. The "info.dvr" file is made up of three objects, that is `DVRVolume()`, `TableOfPlayLists()` and `MakersPrivateData()`.

The syntax of `info.dvr` shown in Fig.15 is explained. The `TableOfPlayLists_Start_address` indicates the leading address of the `TableOfPlayLists()` in terms of the relative number of bytes from the leading byte of the "info.dvr" file. The relative number of bytes is counted beginning from 0.

The `MakersPrivateData_Start_address` indicates the leading address of the `MakersPrivateData()`, in terms of the relative number of bytes as from the leading byte of the "info.dvr" file. The relative number of bytes is counted from 0. The `padding_word` is inserted in association with the syntax of "info.dvr". `N1` and `N2` are optional positive integers. Each padding word may assume an optional value.

The `DVRVolume()` stores the information stating the contents of the volume (disc). Fig.16 shows the syntax of the `DVRVolume`. The syntax of the `DVRVolume()`, shown in Fig.16, is now explained. The `version_number` indicates four character letters indicating the version numbers of the `DVRVolume()`. The `version_number` is encoded to "0045" in association with ISO646.

Length is denoted by 32-bit unsigned integers indicating the number of bytes from directly after the length field to the trailing end of `DVRVolume()`.

The `ResumeVolume()` memorizes the filename of the Real PlayList or the Virtual PlayList reproduced last in the Volume. However, the playback position when the user has interrupted playback of the Real PlayList or the Virtual PlayList is stored in the resume-mark defined in the `PlayListMark()` (see Figs.42 and 43).

Fig.17 shows the syntax of the `ResumeVolume()`. The syntax of the `ResumeVolume()` shown in Fig.17 is explained. The `valid_flag` indicates that the `resume_PlayList_name` field is valid or invalid when this 1-bit flag is set to 1 or 0, respectively.

The 10-byte field of `resume_PlayList_name` indicates the filename of the Real PlayList or the Virtual PlayList to be resumed.

The `UIAppInfoVolume` in the syntax of the `DVRVolume()`, shown in Fig.16, stores parameters of the user interface application concerning the Volume. Fig.18 shows the syntax of the `UIAppInfoVolume`, the semantics of which are now explained. The 8-bit field of `character_set` indicates the encoding method for character letters encoded in the `Volume_name` field. The encoding method corresponds to the values shown in Fig.19.

The 8-bit field of the `name_length` indicates the byte length of the Volume name indicated in the `Volume_name` field. The `Volume_name` field indicates the appellation of the Volume. The number of bytes of the number of the `name_length` counted from left of the field is the number of valid characters and indicates the volume appellation. The values next following these valid character letters may be any values.

The `Volume_protect_flag` is a flag indicating whether or not the contents in the Volume can be shown to the user without limitations. If this flag is set to 1, the contents of the Volume are allowed to be presented (reproduced) to the user only in case the user has succeeded in correctly inputting the PIN number (password). If this flag is set to 0, the contents of the Volume are allowed to be presented to the user even in case the PIN number is not input by the user.

If, when the user has inserted a disc into a player, this flag has been set to 0, or the flag is set to 1 but the user has succeeded in correctly inputting the PIN number, the recording and/or reproducing apparatus 1 demonstrates a list of the PlayList in the disc. The limitations on reproduction of the respective PlayLists are irrelevant to the `Volume_protect_flag` and are indicated by `playback_control_flag` defined in the `UIAppInfoVolume`.

The PIN is made up of four numerical figures of from 0 to 9, each of which is coded in accordance with ISO/IEC 646. The `ref_thumbnail_index` field indicates the information of a thumbnail picture added to the Volume. If the `ref_thumbnail_index` field is of a value other than 0xFFFF, a thumbnail picture is added to the Volume. The thumbnail picture is stored in a `menu.thumb` file. The picture is referenced using the value of the `ref_thumbnail_index` in the `menu.thumb` file. If the `ref_thumbnail_index` field is 0xFFFF, it indicates that a thumbnail picture has been added to the Volume.

The `TableOfPlayList()` in the `info.dvr` syntax shown in Fig.15 is explained. The `TableOfPlayList()` stores the filename of the PlayList (Real PlayList and Virtual

PlayList). All PlayList files recorded in the Volume are contained in the TableOfPlayList(), which TableOfPlayList() indicates the playback sequence of the default of the PlayList in the Volume.

Fig.20 shows the syntax of the TableOfPlayList(), which is now explained. The version\_number of the TableOfPlayList() indicates four character letters indicating the version numbers of the TableOfPlayLists. The version\_number must be encoded to "0045" in accordance with ISO 646.

Length is a unsigned 32-bit integer indicating the number of bytes of the TableOfPlayList() from directly after the length field to the trailing end of the TableOfPlayList(). The 16-bit field of the number\_of\_PlayLists indicates the number of loops of the for-loop inclusive of the PlayList\_file\_name. This numerical figure must be equal to the number of PlayLists recorded in the Volume. The 10-byte numerical figure of the PlayList\_file\_name indicates the filename of the PlayLists.

Fig.21 shows another configuration of the syntax of the TableOfPlayList(). The syntax shown in Fig.21 is comprised of the syntax shown in Fig.20 in which is contained the UIAppInfoPlayList. By such structure including the UIAppInfoPlayList, it becomes possible to create a menu picture simply on reading out the TableOfPlayLists. The following explanation is premised on the use of the syntax shown in Fig.20.

The MakersPrivateData in the info.dvr shown in Fig.15 is explained. The MakersPrivateData is provided to permit the maker of the recording and/or

reproducing apparatus 1 to insert private data of the maker in the `MakersPrivateData()` for special applications of different companies. The private data of each maker has standardized `maker_ID` for identifying the maker who has defined it. The `MakersPrivateData()` may contain one or more `maker_ID`.

If a preset maker intends to insert private data, and the private data of a different maker is already contained in the `MakersPrivateData()`, the new private data is added to the `MakersPrivateData()` without erasing the pre-existing old private data. Thus, in the present embodiment, private data of plural makers can be contained in one `MakersPrivateData()`.

Fig.22 shows the syntax of the `MakersPrivateData`. The syntax of the `MakersPrivateData` shown in Fig.22 is explained. The `version_number` of the `TableOfPlayList()` indicates four character letters indicating the version numbers of the `TableOfPlayLists`. The `version_number` must be encoded to "0045" in accordance with ISO 646. `Length` is a unsigned 32-bit integer indicating the number of bytes of the `TableOfPlayList()` from directly after the `length` field to the trailing end of the `MakersPrivateData()`.

The `mpd_blocks_start_address` indicates the leading end address of the first `mpd_block()` in terms of the relative number of bytes from the leading byte of the `MakersPrivateData()`. The `number_of_maker_entries` is the 16-bit codeless integer affording the number of entries of the maker private data included in the `MakersPrivateData()`. There must not be present two or more maker private data

having the same maker\_ID values in the MakersPrivateData().

The mpd\_blocks\_size is a 16-bit unsigned integer affording one mpd\_block size in terms of 1024 bytes as a unit. For example, if mpd\_block\_size = 1, it indicates that the size of one mpd\_block is 1024 bytes. The number\_of\_mpd\_blocks is a 16-bit unsigned integer affording the number of mpd\_blocks contained in the MakersPrivateData(). The maker\_ID is the 16-bit unsigned integer indicating the model number code of the DVR system which has created the maker private data. The value encoded to the maker\_ID is specified by the licensor.

The maker\_model\_code is a 16-bit unsigned integer indicating the model number code of the DVR system which has created the maker private data. The value encoded to the maker\_model\_code is set by the maker who has received the license of the format. The start\_mpd\_block\_number is a 16-bit unsigned integer indicating the number of the mpd\_block number at which begins the maker private data. The leading end of the maker private data must be aligned with the leading end of the mpd\_block.

The start\_mpd\_block\_number corresponds to a variable j in the for-loop of the mpd\_block.

The mpd\_length is a 32-bit unsigned integer indicating the size of the maker private data. The mpd\_block is an area in which is stored maker private data. All of the mpd\_blocks in the MakersPrivateData() must be of the same size.

The real PlayList file and the Virtual PlayList file, in other words, xxxxx.rpls and yyyyy.vpls, are explained. Fig.23 shows the syntax of xxxxx.rpls (Real PlayList)

and yyyy.ypls (Virtual PlayList), which are of the same syntax structure. Each of the xxxx.rpls and yyyy.ypls is made up of three objects, that is PlayList(), PlayListMark() and MakersPrivateData().

The PlayListMark\_Start\_address indicates the leading address of the PlayListMark(), in terms of the relative number of bytes from the leading end of the PlayList file as a unit. The relative number of bytes is counted from zero.

The MakersPrivateData\_Start\_address indicates the leading address of the MakersPrivateData(), in terms of the relative number of bytes from the leading end of the PlayList file as a unit. The relative number of bytes is counted from zero.

The padding\_word (padding word) is inserted in accordance with the syntax of the PlayList file, with N1 and N2 being optional positive integers. Each padding word may assume an optional value.

PlayList will be further explained in the following although it has been explained briefly. A playback domain in all Clips except Bridge-Clip must be referred by all PlayLists in the disc. Also, two or more Real PlayLists must not overlap the playback domains shown by their PlayItems in the same Clip.

Reference is made to Figs.24A, 24B and 24C. For all Clips, there exist corresponding Real PlayLists, as shown in Fig.24A. This rule is observed even after the editing operation has come to a close, as shown in Fig.24B. Therefore, all Clips must be viewed by referencing one of Real PlayLists.

Referring to Fig.24C, the playback domain of the Virtual PlayList must be

contained in the playback domain and in the Bridge-Clip playback domain. There must not be present in the disc Bridge-Clip not referenced by any Virtual PlayList.

The Real PlayList, containing the list of the PlayItem, must not contain SubPlayItem. The Virtual PlayList contains the PlayItem list and, if the CPI\_type contained in the PlayList() is the EP\_map type and the PlayList\_type is 0 (PlayList containing video and audio), the Virtual PlayList may contain one SubPlayItem. In the PlayList() in the present embodiment, the SubPlayItem is used only for audio post recording. The number of the SubPlayItems owned by one Virtual PlayList must be 0 or 1.

The PlayList is hereinafter explained. Fig.25 shows the PlayList syntax which is now explained. The version\_number indicates four character letters indicating the version numbers of the PlayList(). The version\_number is encoded to "0045" in association with ISO 646. Length is a 32-bit unsigned integer indicating the total number of byte of the PlayList() as from directly after the length field to the trailing end of the PlayList(). The PlayList\_type, one example of which is shown in Fig.26, is an 8-bit field indicating the PlayList type.

The CPI\_type is one-bit flag indicating the value of the CPI\_type of the Clip referenced by the PlayItem() and by the SubPlayItem(). The CPI\_types defined in the CPIs of all Clips referenced by one PlayList must be of the same values. The number\_of\_PlayItems is a 16-bit field indicating the number of PlayItems present in the PlayList.

The `PlayItem_id` corresponding to the preset `PlayItem()` is defined by the sequence in which the `PlayItem()` appears in the for-loop containing the `PlayItem()`. The `PlayItem_id` begins with 0. The `number_of_SubPlayItems` is a 16-bit field indicating the number of `SubPlayItem` in the `PlayList`. This value is 0 or 1. An additional audio stream path (audio stream path) is a sort of a sub path.

The `UIAppInfoPlayList` of the `PlayList` syntax shown in Fig.25 is explained. The `UIAppInfoPlayList` stores parameters of the user interface application concerning the `PlayList`. Fig.27 shows the syntax of the `UIAppInfoPlayList`, which is now explained. The `character_set` is an 8-bit field indicating the method for encoding character letters encoded in the `PlayList_name` field. The encoding method corresponds to the values conforming to the table shown in Fig.19.

The `name_length` is an 8-bit field indicating the byte length of the `PlayList` name indicated in the `PlayList_name` field. The `PlayList_name` field shows the appellation of the `PlayList`. The number of bytes of the number of the `name_length` counted from left of the field is the number of valid characters and indicates the `PlayList` appellation. The values next following these valid character letters may be any values.

The `record_time_and_date` is a 56-bit field storing the date and time on which the `PlayList` was recorded. This field is 14 numerical figures for year/ month/ day/ hour/minute/ second encoded in binary coded decimal (BCD). For example, 2001/ 12/ 23:01:02:03 is encoded to "0x20011223010203".

The duration is a 24-bit field indicating the total replay time of the `PlayList` in

terms of hour/ minute/ second as a unit. This field is six numerical figures encoded in binary coded decimal (BCD). For example, 01:45:30 is encoded to "0x014530".

The valid\_period is a 32-bit field indicating the valid time periods of the PlayList. This field is 8 numerical figures encoded in 4-bit binary coded decimal (BCD). The valid\_period is used in the recording and/or reproducing apparatus 1 e.g., when the PlayList, for which the valid period has lapsed, is to be automatically erased. For example, 2001/05/07 is encoded to "0x20010507".

The maker\_ID is a 16-bit unsigned integer indicating the maker of the DVR player (recording and/or reproducing apparatus 1) which has been the last to update its PlayList. The value encoded to maker\_ID is assigned to the licensor of the DVR format. The maker\_code is a 16-bit unsigned integer indicating the model number of the DVR player which has been the last to update the PlayList. The value encoded to the maker\_code is determined by the maker who has received the license of the DVR format.

If the flag of the playback\_control\_flag is set to 1, its PlayList is reproduced only when the user successfully entered the PIN number. If this flag is set to 0, the user may view the PlayList without the necessity of inputting the PIN number.

If the write\_protect\_flag is set to 1, the contents of the PlayList are not erased nor changed except the write\_protect\_flag. If this flag is set to 0, the user is free to erase or change the PlayList. If this flag is set to 1, the recording and/or reproducing apparatus 1 demonstrates a message requesting re-confirmation by the user before the

user proceeds to erase, edit or overwrite the PlayList.

The Real PlayList, in which the write\_protect\_flag is set to 0, may exist, the Virtual PlayList, referencing the Clip of the Real PlayList may exist, and the write\_protect\_flag of the Virtual PlayList may be set to 1. If the user is desirous to erase the Real PlayList, the recording and/or reproducing apparatus 1 issues an alarm to the user as to the presence of the aforementioned Virtual PlayList or "minimizes" the Real PlayList before erasing the Real PlayList.

If is\_played\_flag is set to 1, as shown in Fig.28B, it indicates that the PlayList was reproduced at least once since it was recorded, whereas, if it is set to 0, it indicates that the PlayList was not reproduced even once since it was recorded.

Archive is a two-bit field indicating whether the PlayList is an original or a copy, as shown in Fig.28C. The field of ref\_thumbnail\_index indicates the information of a thumbnail picture representative of the PlayList. If the ref\_thumbnail\_index field is of a value other than 0xFFFF, a thumbnail picture representative of the PlayList is added in the PlayList, with the PlayList being stored in the menu.thmb file. The picture is referenced using the value of ref\_thumbnail\_index in the menu.thmb file. If the ref\_thumbnail\_index field is 0xFFFF, no thumbnail picture representative of the PlayList is added in the PlayList.

The PlayItem is hereinafter explained. One PlayItem() basically contains the following data: Clip\_Information\_file\_name for specifying the filename of the Clip, IN-time and OUT-time, paired together to specify the playback domain of Clip,

STC\_sequence\_id referenced by IN-time and OUT-time in case the CPI\_type defined in PlayList() is EP\_map type, and Connection\_Condition indicating the connection condition of previous PlayItem and current PlayItem.

If PlayList is made up of two or more PlayItems, these PlayItems are arrayed in a row, without temporal gap or overlap, on the global time axis of the PlayList. If CPI\_type defined in the PlayList is EP\_map type and the current PlayList does not have the BridgeSequence(), the IN-time and OUT-time pair must indicate the same time on the STC continuous domain as that specified by the STC\_sequence\_id. Such instance is shown in Fig.29.

Fig.30 shows such a case in which the CPI\_type defined by PlayList() and, if the current PlayItem has the BridgeSequence(), the rules as now explained are applied. The IN\_time of the PlayItem previous to the current PlayItem, shown as IN\_time1, indicates the time in Bridge-Clip specified in the BridgeSequenceInfo() of the current PlayItem. This OUT\_time must obey the encoding limitations which will be explained subsequently.

The IN\_time of the current PlayItem, shown as IN\_time2, indicates the time in Bridge-Clip specified in the BridgeSequenceInfo() of the current PlayItem. This IN\_time also must obey the encoding limitations as later explained. The OUT\_time of PlayItem of the current PlayItem, shown as OUT\_time2, indicates the time on the STC continuous domain specified by STC\_sequence\_id of the current PlayItem.

If the CPI\_type of PlayList() is TU\_map type, the IN\_time and OUT\_time of

PlayItem, paired together, indicate the time on the same Clio AV stream, as shown in Fig.31.

The PlayItem syntax is as shown in Fig.32. As to the syntax of the PlayItem, shown in Fig.32, the field of the Clip\_information\_file\_name indicates the filename of the Clip Information. The Clip\_stream\_type defined by the ClipInfo() of this Clip Information file must indicate the Clip AV stream.

The STC\_sequence\_id is an 8-bit field and indicates the STC\_sequence\_id of the continuous STC domain referenced by the PlayItem. If the CPI\_type specified in the PlayList() is TU\_map type, this 8-bit field has no meaning and is set to 0. IN\_time is a 32-bit field and used to store the playback start time of PlayItem. The semantics of IN\_time differs with CPI\_type defined in the PlayList(), as shown in Fig.33.

OUT\_time is a 32-bit field and is used to store the playback end time of PlayItem. The semantics of OUT\_time differs with CPI\_type defined in the PlayList(), as shown in Fig.34.

Connection\_condition is a 2-bit field indicating the connection condition between the previous PlayItem and the current PlayItem, as shown in Fig.35. Figs.36A to 36D illustrate various states of Connection\_condition shown in Fig.35.

BridgeSequenceInfo is explained with reference to Fig.37. This BridgeSequenceInfo is the ancillary information of the current PlayItem and includes the following information. That is, BridgeSequenceInfo includes Bridge\_Clip\_Information\_file\_name for specifying the Bridge\_Clip AV file and a

Bridge\_Clip\_Information\_file\_name specifying the corresponding Clip Information file (Fig.45).

It is also an address of a source packet on the Clip AV stream referenced by the previous PlayItem. Next to this source packet is connected the first source packet of the Bridge-Clip AV stream. This address is termed the RSPN\_exit\_from\_previous\_Clip. It is also an address of the source packet on the Clip AV stream referenced by the current PlayItem. Ahead of this source packet is connected the last source packet of the Bridge\_clip AV stream file. This address is termed RSPN\_enter\_to\_current\_Clip.

In Fig.37, RSPN\_arrival\_time\_discontinuity indicates an address of a source packet in the Bridge\_Clip AV stream where there is a discontinuous point in the arrival time base. This address is defined in the ClipInfo() (Fig.46).

Fig.38 shows the syntax of the BridgeSequenceInfo. Turning to the syntax of BridgeSequenceInfo shown in Fig.38, the field of Bridge\_Clip\_Information\_file\_name indicates the filename of the Clip Information file corresponding to the Bridge\_Clip\_Information\_file. The Clip\_stream\_type defined in ClipInfo() of this Clip information file must indicate ‘Bridge\_Clip AV stream’.

The 32-bit field of the RSPN\_exit\_from\_previous\_Clip is a relative address of a source packet on the Clip AV stream referenced by the previous PlayItem. Next to this source packet is connected the first source packet of the Bridge\_Clip AV stream file. The RSPN\_exit\_from\_previous\_Clip has a size based on the source packet

number as a unit, and is counted with the value of the offset\_SPN defined in the ClipInfo() from the first source packet of the Clip AV stream file referenced by the previous PlayItem.

The 32-bit field of RSPN\_enter\_to\_curent\_Clip is the relative address of the source packet on the Clip AV stream referenced by the current PlayItem. Ahead of this source packet is connected the last source packet of the Bridge\_Clip\_AV stream file. The RSPN\_enter\_to\_curent\_Clip has a size that is based on the source packet number as a unit. The RSPN\_enter\_to\_curent\_Clip is counted with the value of the offset\_SPN, defined in the ClipInfo() from the first source packet of the Clip AV stream file referenced by the current PlayItem, as an initial value.

The SubPlayItem is explained with reference to Fig.39. The use of SubPlayItem() is permitted only if the CPI\_type of the PlayList() is the EP\_map type. In the present embodiment, SubPlayItem is used only for audio post recording. The SubPlayItem() includes the following data. First, it includes Clip\_Information\_file\_name for specifying the Clip referenced by the sub path in the PlayList.

It also includes SubPath\_IN\_time and SubPath\_OUT\_time for specifying the sub path playback domain in the Clip. Additionally, it includes sync\_PlayItem\_id and start PTS\_of\_PlayItem for specifying the time of starting the sub path reproduction on the main path time axis. The Clip AV stream, referenced by the sub path, must not contain STC discontinuous points (discontinuous points of the system time base). The

clocks of audio samples of the Clip used in the sub path are locked to the clocks of the audio samples of the main path.

Fig.40 shows the syntax of the SubPlayItem. Turning to the syntax of the SubPlayItem, shown in Fig.40, the field of the Clip\_Information\_file\_name indicates the filename of the Clip Information file and is used by a sub path in the PlayList. The Clip\_stream\_type defined in this ClipInfo() must indicate the Clip AV stream.

An 8-bit field of sync\_PlayItem\_id indicates the sub path type. Here, only '0x00' is set, as shown in Fig.41, while other values are reserved for future use.

The 8-bit field of sync\_PlayItem\_id indicates the PlayItem\_id of the PlayItem containing the time of playback start of the sub path on the time axis of the main path. The value of PlayItem\_id corresponding to the preset PlayItem is defined in the PlayList() (Fig.25).

A 32-bit field of sync\_start PTS\_of\_PlayItem denotes the time of playback start of the sub path on the time axis of the main path, and denotes the upper 32 bits of the PTS (presentation time stamp) on the PlayItem referenced by the sync\_PlayItem\_id. The upper 32 bit field of the SubPath\_IN\_time stores the playback start time of the sub path. SubPath\_IN\_time denotes upper 32 bits of the PTS of 33 bits corresponding to the first presentation unit in the sub path.

The upper 32 bit field of subPath\_OUT\_time stores the playback end time of the sub path. SubPath\_OUT\_time indicates upper 32 bits of the value of the Presentation\_end\_TS calculated by the following equation:

$$\text{Presentation\_end\_TS} = \text{PTS\_OUT} + \text{AU\_duration}$$

where PTS\_out is the PTS of the 33 bit length corresponding to the last presentation unit of the SubPath and AU\_duration is the 90 kHz based display period of the last presentation unit of the SubPath.

Next, PlayListMark() in the syntax of xxxxx.rpls and yyyyy.vpls shown in Fig.23 is explained. The mark information pertinent to the PlayList is stored in this PlayListMark. Fig.42 shows the syntax of PlayListMark. Turning to the syntax of the PlayListMark shown in Fig.42, version\_number is four character letters indicating the version number of this PlayListMark(). The version\_number must be encoded to "0045" in accordance with ISO 646.

Length is an unsigned 32-bit integer indicating the number of bytes of PlayListMark() from directly after the length field to the trailing end of the PlayListMark(). The number\_of\_PlayListMarks is a 16-bit unsigned integer indicating the number of marks stored in the PlayListMark. The number\_of\_PlayListMarks may be zero. The mark\_type is an 8-bit field indicating the mark type and is encoded in the table shown in Fig.43.

A 32-bit field of mark\_time\_stamp stores a time stamp indicating the point specified by the mark. The semantics of the mark\_time\_stamp differ with CPI\_type defined in the PlayList(), as shown in Fig.44. The PlayItem\_id is an 8-bit field specifying the PlayItem where the mark is put. The values of PlayItem\_id corresponding to a preset PlayItem is defined in the PlayList() (see Fig.25).

An 8-bit field of `character_set` shows the encoding method of character letters encoded in the `mark_name` field. The encoding method corresponds to values shown in Fig.19. The 8-bit field of `name_length` indicates the byte length of the mark name shown in the `mark_name` field. The `mark_name` field denotes the mark name indicated in the `mark_name` field. The number of bytes corresponding to the number of `name_lengths` from left of this field is the effective character letters and denotes the mark name. In the `mark_name` field, the value next following these effective character letters may be arbitrary.

The field of the `ref_thumbnail_index` denotes the information of the thumbnail picture added to the mark. If the field of the `ref_thumbnail_index` is not 0xFFFF, a thumbnail picture is added to its mark, with the thumbnail picture being stored in the `mark.thmb` file. This picture is referenced in the `mark.thmb` file, using the value of `ref_thumbnail_index`, as explained subsequently. If the `ref_thumbnail_index` field is 0xFFFF, it indicates that no thumbnail picture is added to the mark.

The Clip Information file is now explained. The `zzzzz.clpi` (Clip Information file) is made up of six objects, as shown in Fig.45. These are `ClipInfo()`, `STC_Info()`, `Program()`, `CPI()`, `ClipMark()` and `MakersPrivateData()`. For the AV stream (Clip AV stream or Bridge-Clip AV stream) and the corresponding Clip Information file, the same string of numerals “`zzzzz`” is used.

Turning to the syntax of `zzzzz.clpi` (Clip Information file) shown in Fig.45 is explained. The `ClipInfo_Start_address` indicates the leading end address of `ClipInfo()`

with the relative number of bytes from the leading end byte of the zzzzz.clpi file as a unit. The relative number of bytes is counted from zero.

The STC\_Info\_Start\_address indicates the leading end address of STC\_Info with the relative number of bytes from the leading end byte of the zzzzz.clpi file as a unit. The ProgramInfo\_Start\_address indicates the leading end address of ProgramInfo() with the relative number of bytes from the leading end byte of the zzzzz.clpi file as a unit. The relative number of bytes is counted from 0. The CPI\_Start\_address indicates the leading end address of CPI() with the relative number of bytes from the leading end byte of the zzzzz.clpi file as a unit. The relative number of bytes is counted from zero.

The ClipMark\_Start\_address indicates the leading end address of ClipMark() with the relative number of bytes from the leading end byte of the zzzzz.clpi file as a unit. The relative number of bytes is counted from zero. The \_MakersPrivateData\_Start\_address indicates the leading end address of MakersPrivateData() with the relative number of bytes from the leading end byte of the zzzzz.clpi file as a unit. The relative number of bytes is counted from zero. The padding\_word is inserted in accordance with the syntax of the zzzzz.clpi file. N1, N2, N3, N4 and N5 must be zero or optional positive integers. The respective padding words may also assume optional values.

The ClipInfo is now explained. Fig.46 shows the syntax of ClipInfo. Fig.46 shows the syntax of ClipInfo. In the ClipInfo() is stored the attribute information of

corresponding AV stream files (Clip AV stream or Bridge-Clip AV stream file).

Turning to the syntax of the ClipInfo shown in Fig.46, `version_number` is the four character letters indicating the version number of this `ClipInfo()`. The `version_number` must be encoded to "0045" in accordance with the ISO 646. `Length` is a 32-bit unsigned integer indicating the number of bytes of `ClipInfo()` from directly at back of the length field to the trailing end of the `ClipInfo()`. An 8-bit field of `Clip_stream_type` indicates the type of the AV stream corresponding to the Clip Information file, as shown in Fig.47. The stream types of the respective AV streams will be explained subsequently.

The 32-bit field of `offset_SPN` gives an offset value of the source packet number of the first source packet number of the first source packet of the AV stream (Clip AV stream or the Bridge-Clip AV stream). When the AV stream file is first recorded on the disc, this `offset_SPN` must be zero.

Referring to Fig.48, when the beginning portion of the AV stream file is erased by editing, `offset_SPN` may assume a value other than 0. In the present embodiment, the relative source packet number (relative address) referencing the `offset_SPN` is frequently described in the form of `RSPNxxx`, where `xxx` is modified such that `RSPN_xxx` is `RAPN_EP_start`. The relative source packet number is sized with the source packet number as a unit and is counted from the first source packet number of the AV stream file with the value of the `offset_SPN` as the initial value.

The number of source packets from the first source packet of the AV stream file

to the source packet referenced by the relative source packet number (SPN\_xxx) is calculated by the following equation:

$$\text{SPN}_\text{xxx} = \text{RSPN}_\text{xxx} - \text{offset}_\text{SPN}.$$

Fig.48 shows an instance in which offset\_SPN is 4.

TS\_recording\_rate is a 24-bit unsigned integer, which affords an input/output bit rate required for the AV stream to the DVR drive (write unit 22) or from the DVR drive (readout unit 28). The record\_time\_and\_date is a 56-bit field for storing the date and time of recording of the AV stream corresponding to the Clip and is an encoded representation of year/month/day/hour/minute in 4-bit binary coded decimal (BCD) for 14 numerical figures. For example, 2001/2/23:01:02:03 is encoded to "0x20011223010203".

The duration is a 24-bit field indicating the total playback time of the Clip by hour/minute/second based on arrival time clocks. This field is six numerical figures encoded in 4-bit binary coded decimal (BCD). For example, 01:45:30 is encoded to "0x014530".

A flag time\_controlled\_flag indicates the recording mode of an AV stream file. If this time\_controlled\_flag is 1, it indicates that the recording mode is such a mode in which the file size is proportionate to the time elapsed since recording, such that the condition shown by the following equation:

$$\begin{aligned} \text{Ts\_average\_rate} * 192 / 188 * (t - \text{start\_time}) - \alpha &\leq \text{size\_clip}(t) \\ &\leq \text{TS\_average\_rate} * 192 / 188 * (t - \text{start\_time}) + \alpha \end{aligned}$$

where `TS_average_rate` is an average bit rate of the transport stream of the AV stream file expressed by bytes/second.

In the above equation, `t` denotes the time in seconds, while `start_time` is the time point when the first source packet of the AV stream file was recorded. The `size_clip(t)` is  $10*192$  bytes and  $\alpha$  is a constant dependent on `TS_average_rate`.

If `time_controlled_flag` is set to 0, it indicates that the recording mode is not controlling so that the time lapse of recording is proportionate to the file size of the AV stream. For example, the input transport stream is recorded in a transparent fashion.

If `time_controlled_flag` is set to 1, the 24-bit field of `TS_average_rate` indicates the value of `TS_average_rate` used in the above equation. If `time_controlled_flag` is set to 0, this field has no meaning and must be set to 0. For example, the variable bit rate transport stream is encoded by the following sequence: First, the transport rate is set to the value of `TS_recording_rate`. The video stream is encoded with a variable bit rate. The transport packet is intermittently encoded by not employing null packets.

The 32-bit field of `RSPN_arrival_time_discontinuity` is a relative address of a site where arrival timebase discontinuities are produced on the Bridge-Clip AV stream file. The `RSPN_arrival_time_discontinuity` is sized with the source packet number as a unit and is counted with the value of `offset_SPN` defined in the `ClipInfo()` as from the first source packet of the Bridge-Clip AV stream file. An absolute address in the Bridge-Clip AV stream file is calculated based on the aforementioned equation:

$$\text{SPN}_\text{xxx} = \text{RSPN}_\text{xxx} - \text{offset}_\text{SPN}.$$

The 144-bit field of `reserver_for_system_use` is reserved for a system. If `is_format_identifier_valid` flag is 1, it indicates that the field of `format_identifier` is effective. If `is_format_identifier_valid` flag is 1, it indicates that the `format_identifier` field is valid. If `is_original_network_ID_valid` flag is 1, it indicates that the field of `is_transport_stream_ID-valid` is valid. If the flag `is_transport_stream_ID-valid` is 1, it indicates that the `transport_stream_ID` field is valid. If `is_servece_ID_valid` flag is 1, it indicates that the `servece_ID` field is valid.

If `is_country_code_valid` flag is 1, it indicates that the field `country_code` is valid. The 32-bit field of `format_identifier` indicates the value of `format_identifier` owned by a registration descriptor (defined in ISO/IEC13818-1) in the transport stream. The 16-bit field of `original_network_ID` indicates the value of the `original_network_ID` defined in the transport stream.

The 16-bit field in `servece_ID` denotes the value of `servece_ID` defined in the transport stream. The 24-bit field of `country_code` shows a country code defined by ISO3166. Each character code is encoded by ISO8859-1. For example, Japan is represented as "JPN" and is encoded to "0x4A 0x50 0x4E". The `stream_format_name` is 15 character codes of ISO-646 showing the name of a format organization affording stream definitions of transport streams. An invalid byte in this field has a value of '0xFF'.

`Format_identifier`, `original_network_ID`, `transport_stream_ID`, `servece_ID`, `country_code` and `stream_format_name` indicate service providers of transport streams.

This allows to recognize encoding limitations on audio or video streams and stream definitions of private data streams other than audio video streams or SI (service information). These information can be used to check if the decoder is able to decode the stream. If such decoding is possible, the information may be used to initialize the decoder system before starting the decoding.

STC\_Info is now explained. The time domain in the MPEG-2 transport stream not containing STC discontinuous points(discontinuous points of the system time base) is termed the STC\_sequence. In the Clip, STC\_sequence is specified by the value of STC\_sequence\_id. Figs.50A and 50B illustrate a continuous STC domain. The same STC values never appear in the same STC\_sequence, although the maximum time length of Clip is limited, as explained subsequently. Therefore, the same PTS values also never appear in the same STC\_sequence. If the AV stream contains  $N$  STC discontinuous points, where  $N > 0$ , the Clip system time base is split into  $(N+1)$  STC\_sequences.

STC\_Info stores the address of the site where STC discontinuities (system timebase discontinuities) are produced. As explained with reference to Fig.51, the RSPN\_STC\_start indicates the address and begins at a time point of arrival of the source packet referenced by the  $(k+1)$ st RSPN\_STC\_start and ends at a time point of arrival of the last source packet.

Fig.52 shows the syntax of the STC\_Info. Turning to the syntax of STC\_Info shown in Fig.52, version\_number is four character letters indicating the version

number of STC\_Info(). The version\_number must be encoded to "0045" in accordance with ISO 646.

Length is a 32-bit unsigned integer indicating the number of bytes of STC\_Info() from directly after this length field to the end of STC\_Info. If CPI\_type of CPI() indicates TU\_map type, 0 may be set in this length field. If CPI\_type of CPI() indicates EP\_map type, the num\_of\_STC\_sequence must be of a value not less than 1.

An 8-bit unsigned integer of num\_of\_STC\_sequence indicates the number of sequences in the Clip. This value indicates the number of the for-loops next following the field. The STC\_sequence\_id corresponding to the preset STC\_sequence is defined by the order in which appears the RSPN\_STC\_start corresponding to the STC\_sequence in the for-loop containing the RSPN\_STC\_start. The STC\_sequence\_id commences at 0.

The 32-bit field of RSPN\_STC\_start indicates an address at which the STC\_sequence commences on the AV stream file. RSPN\_STC\_start denotes an address where system time base discontinuities are produced in the AV stream file. The RSPN\_STC\_start may also be a relative address of the source packet having the first PCR of the new system time base in the AV stream. The RSPN\_STC\_start is of a size based on the source packet number and is counted from the first source packet of the AV stream file with the offset\_SPN value defined in ClipInfo() as an initial value. In this AV stream file, the absolute address is calculated by the above-value.

mentioned equation, that is

SPN\_xxx = RSPN\_xxx - offset\_SPN.

ProgramInfo in the syntax of zzzz.clip shown in Fig.45 is now explained with reference to Fig.53. The time domain having the following features in the Clip is termed program\_sequence. These feature are that the value of PCR\_PID is not changed, the number of audio elementary streams is also not changed, the PID values in the respective video streams are not changed, the encoding information which is defined by VideoCodingInfo thereof is not changed, the number of audio elementary streams is also not changed, the PID values of the respective audio streams are not changed, and that the encoding information, which is defined by AudioCodingInfo thereof, is not changed.

Program\_sequence has only one system time base at the same time point. Program\_sequence has a sole PMT at the same time point. ProgramInfo() stores the address of the site where the program\_sequence commences. RSPN program sequence-start indicates the address.

Fig.54 illustrates the syntax of ProgramInfo. Turning to the ProgramInfo shown in Fig.54, version\_number is four character letters indicating the version number of ProgramInfo(). The version\_number must be encoded to "0045" in accordance with ISO 646.

Length is a 32-bit unsigned integer indicating the number of bytes of ProgramInfo() from directly at back of this length field to the end of program(info()).

If CPI\_type of CPI() indicates the TU\_map type, this length field may be set to 0. If the CPI\_type of CPI() indicates EP\_map type, the number\_of\_programs must be of a value not less than 1.

An 8-bit unsigned integer of number\_of\_program\_sequences denotes the number of program\_sequences in the Clip. This value indicates the number of for-loops next following this field. If program\_sequence in the Clip is not changed, 1 must be set in the number of program\_sequences. A 32-bit field of RSPN\_program\_sequence\_start is a relative address where the program sequence commences on the AV stream.

RSPN\_program\_sequence\_start is sized with the source packet number as a unit and is counted with the value of offset\_SPN defined in the ClipInfo() as from the first source packet of the AV stream file. An absolute address in the AV stream file is calculated by:

$$\text{SPN\_xxx} = \text{RSPN\_xxx} - \text{offset\_SPN}.$$

The values of RSPN\_program\_sequence\_start in the for-loop syntax must appear in the rising order.

A 16-bit field of PCR\_PID denotes the PID of the transport packet containing an effective PCR field effective for the program\_sequence. An 8-bit field of number\_of\_audios indicates the number of for-loops containing audio\_stream\_PID and AudioCodingInfo(). A 16-bit field of video\_stream\_PID indicates the PID of the transport packet containing a video stream effective for its program\_sequence.

`VideoCodingInfo()`, next following this field, must explain the contents of the video stream referenced by its `video_stream_PID`.

A 16-bit field of `audio_stream_PID` indicates the PID of a transport packet containing the audio stream effective for its `program_sequence`. The `AudioCodingInfo()`, next following this field, must explain the contents of the video stream referenced by its `audio_stream_PID`.

The order in which the values of `video_stream_PID` in the for-loop of the syntax must be equal to the sequence of PID encoding of the video stream in the PMT effective for the `program_sequence`. Additionally, the order in which the values of `audio_stream_PID` appears in the for-loop of the syntax must be equal to the sequence of PID encoding of the audio stream in the PMT effective for the `program_sequence`.

Fig.55 shows the syntax of `VideoCodingInfo` in the syntax of the `ProgramInfo` shown in Fig.54. Turning to the syntax of the `VideoCodingInfo` shown in Fig.55, an 8-bit field of `video_format` indicates the video format corresponding to `video_stream_PID` in `ProgramInfo()`, as shown in Fig.56.

Referring to Fig.57, an 8-bit field of `frame_rate` indicates the video frame rate corresponding to the `video_stream_PID` in `ProgramInfo()`. An 8-bit field of `display_aspect_ratio` indicates a video display aspect ratio corresponding to `video_stream_PID` in `ProgramInfo()`.

Fig.59 shows the syntax of `AudioCodingInfo` in the syntax of `ProgramInfo` shown in Fig.54. Turning to the syntax of the `AudioCodingInfo` shown in Fig.59, an

8-bit field of `audio_format` indicates the audio encoding method corresponding to `audio_stream_PID` in `ProgramInfo()`, as shown in Fig.60.

An 8-bit field of `audio_component_type` indicates an audio component type corresponding to `audio_stream_PID` in `ProgramInfo()` as shown in Fig.61, whilst an 8-bit field of `sampling_frequency` indicates an audio sampling frequency corresponding to `audio_stream_PID` in `ProgramInfo()` as shown in Fig.62.

The CPI (Characteristics Point Information) in the syntax of `zzzzz.clip` shown in Fig.45 is explained. The CPI is used for correlating the time information in the AV stream with the address in its file. The CPI is of two types, namely `EP_map` and `TU_map`. In Fig.63, if `CPI_type` in `CPI()` is `EP_map`, its `CPI()` contains `EP_map`. In Fig.64, if `CPI_type` in `CPI()` is `TU_map`, its `CPI()` contains `TU_map`. One AV stream has one `EP_map` or one `TU_map`. If the AV stream is an SESF transport stream, the corresponding Clip must own an `EP_map`.

Fig.65 show the syntax of CPI. Turning to the syntax of CPI shown in Fig.65, the `version_number` is four character letters indicating the version number of this `CPI()`. The `version_number` must be encoded to "0045" in accordance with ISO 646. `Length` is a 32-bit unsigned integer indicating the number of bytes as from directly after this length field to the trailing end of the `CPI()`. The `CPI_type` is a 1-bit flag and indicates the CPI type of Clip, as shown in Fig.66.

The `EP_map` in the CPI syntax shown in Fig.65 is explained. There are two types of the `EP_map`, that is `EP_map` for a video stream and an `EP_map` for an audio

stream. The EP\_map\_type in the EP\_map differentiates between these EP\_map types. If the Clip contains one or more video streams, the EP\_map for the video stream must be used. If the Clip does not contain a video stream but contains one or more audio streams, the EP\_map for the audio stream must be used.

The EP\_map for a video stream is explained with reference to Fig.67. The EP\_map for the video stream has data stream\_PID, PTS\_EP\_start and RSPN\_EP\_start. The stream\_PID shows the PID of the transport packet transmitting a video stream. The PTS\_EP\_start indicates the PTS of an access unit beginning from the sequence header of the video stream. The RSPN\_EP\_start indicates the address of a source packet including the first byte of the access unit referenced by the PTS\_EP\_start in the AV stream.

A sub table, termed EP\_map\_for\_one\_stream\_PID() is created from one video stream transmitted by the transport packet having the same PID to another. If plural video streams exist in the Clip, the EP\_map may contain plural EP\_map\_for\_one\_stream\_PID().

The EP\_map for audio stream has data stream\_PID, PTS\_EP\_start and RSPN\_EP\_start. The stream\_PID shows a PID of a transport packet transmitting an audio stream. The PTS\_EP\_start shows the PTS of an accessing unit in the audio stream. The RSPN\_EP\_start indicates an address of a source packet containing a first byte of the access unit referenced by PTS\_EP\_start of the AV stream.

The sub table termed EP\_map\_for\_one\_stream\_PID() is created from one audio

stream transmitted by the transport packet having the same PID to another. If there exist plural audio streams in the Clip, EP\_map may contain plural EP\_map\_for\_one\_stream\_PID().

Turning to the relation between EP\_map and STC\_Info, one EP\_map\_for\_one\_stream\_PID() is created in one table irrespective of discontinuous points in the STC. Comparison of the value of the RSPN\_EP\_start to the value of RSPN\_STC\_start defined in STC\_Info() reveals the boundary of data of EP\_map belonging to respective STC\_sequences (see Fig.68). The EP\_map must have one EP\_map\_for\_one\_stream\_PID for a continuous stream range transmitted by the same PID. In the case shown in Fig.69, program#1 and program#3 have the same video PID, however, the data range is not continuous, so that EP\_map\_for\_one\_stream\_PID must be provided for each program.

Fig.70 shows the EP\_map syntax. By way of explanation of the EP\_map syntax shown in Fig.70, the EP\_type is a 4-bit field and shows the EP\_map entry point type, as shown in Fig.71. The EP\_type shows the semantics of the data field next following this field. If Clip includes one or more video stream, the EP\_type must be set to 0 ('video'). Alternatively, if the Clip contains no video stream but contains one or more audio stream, then EP\_type must be set to 1 ('audio').

The 16-bit field of number\_of\_stream\_PIDs indicates the number of times of loops of the for-loop having number\_of\_stream\_PIDs in the EP\_map() as a variable. The 16-bit field of stream\_PID(k) indicates the PID of the transport packet transmitting

the number  $k$  elementary stream (video or audio stream) referenced by `EP_map_for_one_stream_PID` (`num_EP_entries(k)`). If `EP_type` is 0 ('video'), its elementary stream must be a video stream. If `EP_type` is equal to 1 ('audio'), its elementary stream must be the audio stream.

The 16-bit field of `num_EP_entries(k)` indicates the `num_EP_entries(k)` referenced by `EP_map_entries(k)`. The `EP_map_for_one_stream_PID_Start_address(k)`: This 32-bit field indicates the relative address position at which the `EP_map_for_one_stream_PID`(`num_EP_entries(k)`) begins in the `EP_map()`. This value is indicated by the size as from the first byte of the `EP_map()`.

`Padding_word` must be inserted in accordance with the `EP_map()` syntax. `X` and `Y` must be optional positive integers. The respective padding words may assume any optional values.

Fig.72 shows the syntax of `EP_map_for_one_stream_PID`. By way of explanation of the syntax of the `EP_map_for_one_stream_PID` shown in Fig.72, the semantics of the 32-bit field of `PTS_EP_start` differs with the `EP_type` defined by `EP_map()`. If `EP_type` is equal to 0 ('video'), this field has upper 32 bits of the 33-bit precision PTS of the access unit beginning with a sequence header of the video stream. If the `EP_type` is equal to 1 ('audio'), this field has upper 32 bits of PTS of 33 bit precision of the access unit of the audio stream.

The semantics of the 32-bit field of `RSPN_EP_start` differs with the `EP_type` defined in `EP_map()`. If `EP_type` is equal to 0 ('video'), this field indicates the relative

address of the source packet including the first byte of the sequence header of the access unit referenced by the PTS\_EP\_start in the AV stream. Alternatively, if EP\_type is equal to 1 ('audio'), this field indicates the relative address of the source packet containing the first byte in the audio stream of the access unit referenced by the PTS\_EP\_start in the AV stream.

RSPN\_EP\_start is of a size which is based on the source packet number as a unit, and is counted from the first source packet of the AV stream file, with the value of the offset\_SPN, defined in ClipInfo(), as an initial value. The absolute address in the AV stream file is calculated by

$$\text{SPN}_\text{xxx} = \text{RSPN}_\text{xxx} - \text{offset}_\text{SPN}.$$

It is noted that the value of the RSPN\_EP\_start in the syntax must appear in the rising order.

The TU\_map is now explained with reference to Fig.73. TU\_map forms a time axis based on the source packet arrival time clock (timepiece of the arrive time base). This time axis is termed TU\_map\_time\_axis. The point of origin of TU\_map\_time\_axis is indicated by offset\_time in the TU\_map(). TU\_map\_time\_axis is divided in a preset unit as from offset\_time, this unit being termed time\_unit.

In each time\_unit in the AV stream, addresses on the AV stream file of the source packet in the first complete form are stored in TU\_map. These addresses are termed RSPN\_time\_unit\_start. The time at which begins the  $k (k \geq 0)$ th time\_unit on the TU\_map\_time\_axis is termed TU\_start\_time( $k$ ). This value is calculated based on

the following equation:

`TU_start_time(k) = offset_time + k*time unit size.`

It is noted that `TU_start_time(k)` has a precision of 45 kHz.

Fig.74 shows the syntax of TU\_map. By way of explanation of the TU\_map syntax shown in Fig.74, the 32-bit field of offset\_time gives an offset time relative to TU\_map\_time\_axis. This value indicates the offset time relative to the first time\_unit in the Clip. The offset\_time is of a size based on 45 kHz clock derived from the 27 MHz precision arrival time clocks as unit. If the AV stream is to be recorded as new Clip, offset\_time must be set to 0.

The 32-bit field of `time_unit_size` affords the size of the `time_unit`, and is based on 45 kHz clocks, derived from the 27 MHz precision arrival time clocks, as unit. Preferably, `time_unit_size` is not longer than one second ( $time\_unit\_size \leq 45000$ ). The 32 bit field of `number_of_time_unit_entries` indicates the number of entries stored in `TU_map()`.

The 32-bit field of `RSN_time_unit_start` indicates the relative address of a site in the AV stream at which begins each `time_unit`. `RSN_time_unit_start` is of a size based on the source packet number as unit and is counted with the value of `offset_SPN` defined in `ClipInfo()` as from the first source packet of the AV stream file as an initial value. The absolute address in the AV stream file is calculated by

SPN xxx = RSPN xxx - offset SPN.

It is noted that the value of RSN\_time unit start in the for-loop of the syntax

must appear in the rising order. If there is no source packet in the number (k+1) time\_unit, the number (k+1) RSN\_time\_unit\_start must be equal to the number k RSPN\_time\_unit\_start.

By way of explanation of the ClipMark in the syntax of zzzzz.clip shown in Fig.45, the ClipMark is the mark information pertinent to clip and is stored in the ClipMark. This mark is not set by a user, but is set by a recorder (recording and/or reproducing apparatus 1).

Fig.75 shows the ClipMark syntax. By way of explanation of the ClipMark syntax shown in Fig.75, the version\_number is four character letters indicating the version number of this ClipMark. The version\_number must be encoded in accordance with ISO 646 to "0045".

Length is a 32-bit unsigned integer indicating the number of bytes of the ClipMark() as from directly after the length field to the trailing end of ClipMark(). The number\_of\_Clip\_marks is a 16-bit unsigned integer indicating the number of marks stored in ClipMark and may be equal to 0. Mark\_type is an 8-bit field indicating the mark type and is encoded in accordance with the table shown in Fig.76.

Mark\_time\_stamp is a 32-bit field and stores the time stamp indicating a pointer having a specified mark. The semantics of mark\_time\_stamp differs with CPI\_type in the PlayList(), as shown in Fig.77.

If CPI\_type in CPI() indicates the EP\_map type, this 8-bit field indicates the STC\_sequence\_id of the continuous STC domain where there is placed

`mark_time_stamp`. If `CPI_type` in `CPI()` indicates `TU_map` type, this 8-bit field has no meaning but is set to 0. The 8-bit field of `Character_set` indicates the indicating method of character letters encoded in the `mark_name` field. The encoding method corresponds to the value shown in Fig.19.

The 8-bit field of `name_length` indicates the byte length of the mark name shown in the `mark_name` field. This `mark_name` field indicates the mark name. The byte number corresponding to the number of the `name_length` from left of this field is the effective character number and denotes the mark name. In the `mark_name` field, the values next following these effective character letters may be arbitrary.

The field of `ref_thumbnail_index` indicates the information of the thumbnail picture appended to the mark. If the `ref_thumbnail_index` field is of a value different from 0xFFFF, a thumbnail picture is added to its mark, with the thumbnail picture being stored in the `mark.thumb` file. This picture is referenced using the value of `ref_thumbnail_index` in the `mark.thumb` file. If the `ref_thumbnail_index` field is of a value equal to 0xFFFF, a thumbnail picture is not appended to its mark.

Fig.78 shows the syntax of `menu.thmb` and `mark.thmb` and Fig.79 the syntax of `Thumbnail` in the syntax of `menu.thmb` and `mark.thmb` shown in Fig.78. By way of explanation of the syntax of `Thumbnail`, shown in Fig.79, `version_number` is four character letters denoting the version number of this `Thumbnail()`. `Version_number` must be encoded to "0045" in accordance with ISO 646.

`Length` is a 32-bit unsigned integer indicating the number of bytes of

`MakerPrivateData()` as from directly at back of the length field up to the trailing end of `Thumbnail()`. `Tu_block_start_address` is a 32-bit unsigned integer indicating the leading end byte address of the first `tn_block`, in terms of the relative number of bytes as from the leading end byte of `Thumbnail()` as a unit. The number of relative bytes is counted from 0. `Number_of_thumbnails` is a 16-bit unsigned integer which gives the number of entries of a thumbnail picture contained in `Thumbnail()`.

`Tu_block_size` is a 16-bit unsigned integer which gives the size of one `tn_block`, in terms of 1024 bytes as a unit. If, for example, `tn_block_size` = 1, it indicates that the size of one `tn_block` is 1024 bytes. `Number_of_tn_blocks` is a 116-bit unsigned integer indicating the number of entries of `tn_block` in this `Thumbnail()`. `Thumbnail_index` is a 16-bit unsigned integer indicating the index number of the thumbnail picture represented by the thumbnail information for one for-loop beginning from the `thumbnail_index` field. The value 0xFFFF must not be used as `Thumbnail_index`. This `Thumbnail_index` is referenced by `ref_thumbnail_index` in `UIAppInfoVolume()`, `UIAppInfoPlayList()`, `PlayListMark()` and `ClipMark()`.

`Thumbnail_picture_format` is an 8-bit unsigned integer representing the picture format of a thumbnail picture and assumes a value shown in Fig.80. In the table, DCF and PNG are allowed only in `menu.thumb`. The mark thumbnail must assume the value of "0x00" (MPEG-2 Video 1-picture).

`Picture_data_size` is a 32-bit unsigned integer indicating the byte length of a thumbnail picture in terms of bytes as a unit. `Start_tn_block_number` is a 16-bit

unsigned integer indicating the tn\_block number of the tn\_block where data of the thumbnail picture begins. The leading end of the thumbnail picture data must coincide with the leading end of the tn\_block. The tn\_block number begins from 0 and is relevant to the value of a variable k in the for-loop of tn\_block.

X\_picture\_length is a 16-bit unsigned integer indicating the number of pixels in the horizontal direction of a frame of a thumbnail picture. Y\_picture\_length is a 16-bit unsigned integer indicating the number of pixels in the vertical direction of a frame of a thumbnail picture. Tn\_block is an area in which to store a thumbnail picture. All tn\_block in the Thumbnail() are of the same size (fixed length) and are of a size defined by tn\_block\_size.

Figs.81A and 81B schematically show how thumbnail picture data are stored in tn\_block. If, as shown in Figs.81A and 81B, the thumbnail picture begins at the leading end of tn\_block, and is of a size exceeding 1 tn\_block, it is stored using the next following tn\_block. By so doing, data with a variable length can be managed as fixed length data, so that the editing of deletion can be coped with by simpler processing.

An AV stream file is now explained. The AV stream file is stored in the "M2TS" directory (Fig.14). There are two types of the AV stream file, namely a Clip A stream file and a Bridge-Clip AV stream file. Both AV streams must be of the structure of DVR MPEG-2 transport stream file as hereinafter defined.

First, the DVR MPEG2 transport stream is explained. The structure of the DVR MPEG-2 transport stream is shown in Fig.82. The AV stream file has the structure of

a DVR MPEG 2 transport stream. The DVR MPEG 2 transport stream is made up of an integer number of Aligned units. The size of the aligned unit is 6144 bytes (2048\*3 bytes). The Aligned unit begins from the first byte of the source packet. The source packet is 192 bytes long. One source packet is comprised of TP\_extra\_header and a transport packet. TP\_extra\_header is 4 bytes long, with the transport packet being 188 bytes long.

One Aligned unit is made up of 32 source packets. The last Aligned unit in the DVR MPEG 2 transport stream is also made up of 32 source packets. Therefore, the DVR MPEG 2 transport stream ends at a boundary of the Aligned unit. If the number of the transport packets of the input transport stream recorded on a disc is not a multiple of 32, a source packet having a null packet (transport packet of PID = 0x1FFF) must be used as the last Aligned unit. The file system must not use excess information in the DVR MPEG 2 transport stream.

Fig.83 shows a recorder model of the DVR MPEG 2 transport stream. The recorder shown in Fig.83 is a conceptual model for prescribing the recording process. The DVR MPEG 2 transport stream obeys this model.

The input timing of the MPEG 2 transport stream is now explained. The input MPEG 2 transport stream is a full transport stream or a partial transport stream. The input MPEG 2 transport stream must obey the ISO/IEC13818-1 or ISO/IEC 13818-9. The number  $i$  byte of the MPEG 2 transport stream is input simultaneously at time  $t(i)$  to T-STD (transport stream system target decoder provided for in ISO/IEC13818-1) and

to the source packetizer.  $R_{pk}$  is an instantaneous maximum value of the input rate of the transport packet.

A 27 MHz PLL 52 generates a frequency of 27 MHz clock. The 27 MHz clock frequency is locked at a value of the program clock reference (PCR) of the MPEG 2 transport stream. An arrival time clock counter 53 counts the pulses of the 27 MHz frequency.  $Arrival\_time\_clock(i)$  is a count value of the arrival time clock counter at time  $t(i)$ .

A source packetizer 54 appends TP\_extra\_header to the totality of the transport packets to create a source packet.  $Arrival\_time\_stamp$  indicates the time when the first byte of the transport packet reaches both the T-STD and the source packetizer.  $Arrival\_time\_stamp(k)$  is a sampled value of the  $Arrival\_time\_clock(k)$  as represented by the following equation:

$$arrival\_time\_stamp(k) = arrival\_time\_clock(k) \% 230$$

where  $k$  denotes the first byte of the transport packet.

If the time separation between two neighboring transport packets is  $230/2\ 7000000$  sec (about 40 sec) or longer, the difference of the  $arrival\_time\_stamp$  of the two transport packets should be set to  $230/2\ 7000000$  sec. The recorder is provided for such case.

A smoothing buffer 55 smoothes the bitrate of the input transport stream. The smoothing buffer must not overflow.  $R_{max}$  is the output bitrate of the source packet from the smoothing buffer when the smoothing buffer is not null. If the smoothing

buffer is null, the output bitrate of the smoothing buffer is 0.

Next, the parameters of the recorder model of the DVR MPEG 2 transport stream are explained. The value of Rmax is given by `TS_recording_rate` as defined in `ClipInfo()` associated with the AV stream file. This value may be calculated from the following equation:

$$R_{max} = TS\_recording\_rate * 192 / 188$$

where the value of `TS_recording_rate` is of a size in bytes/second.

If the input transport stream is an SESF transport stream, `Rpk` must be equal to `TS_recording_rate` as defined in `ClipInfo()` associated with the AV stream file. If the input transport stream is not an SESF transport stream, reference may be made to values defined e.g., in a descriptor of the MPEG 2 transport stream, such as `maximum_bitrate_descriptor` or `partial_stream_descriptor` for this value.

If the input transport stream is an SESF transport stream, the smoothing buffer size is 0. If the input transport stream is not an SESF transport stream, reference may be made to values defined in the descriptor of the MPEG 2 transport stream, such as, for example, the values defined in the `smoothing_buffer_descriptor`, `short_smoothing_buffer_descriptor` or in the `partial_transport_stream_descriptor`.

For the recorder and the player (reproducing apparatus), a sufficient size buffer needs to be provided. The default buffer size is 1536 bytes.

Next, a player model of the DVR MPEG 2 transport stream is explained. Fig.84 shows a player model of the DVR MPEG 2 transport stream. This is a conceptual

model for prescribing the reproduction process. The DVR MPEG 2 transport stream obeys this model.

A 27 MHz X-tal 61 generates the frequency of 27 MHz. An error range of the 27MHz frequency must be  $\pm 30$  ppm ( $27000000 \pm 810$  Hz). The arrival time clock counter 62 is a binary counter for counting the pulses of the frequency of 27 MHz. Arrival\_time\_clock(i) is a count value of the arrival time clock counter at time  $t(i)$ .

In the smoothing buffer 64,  $R_{max}$  is the input bitrate of the source packet to the smoothing buffer when the smoothing buffer is not full. If the smoothing buffer is full, the input bitrate to the smoothing buffer is 0.

By way of explaining the output timing of the MPEG 2 transport stream, if the arrival\_time\_stamp of the current source packet is equal to 30 bits on the LSB side of arrival\_time\_clock(i), the transport packet of the source packet is removed from the smoothing buffer.  $R_{pk}$  is an instantaneous maximum value of the transport packet rate. The overflow of the smoothing buffer is not allowed.

The parameters of the player model of the DVR MPEG 2 transport stream are the same as those of the recorder model of the DVR MPEG 2 transport stream described above.

Fig.85 shows the syntax of the source packet. Transport\_packet() is an MPEG 2 transport stream provided in ISO/IEC 13818-1. The syntax of TP\_Extra-header in the syntax of the source packet shown in Fig.85 is shown in Fig.86. By way of explaining the syntax of the TP\_Extra-header, shown in Fig.86, copy\_permission\_indicator is an

integer representing the copying limitation of the payload of the transport packet. The copying limitation may be copy free, no more copy, copy once or copying prohibited. Fig.87 shows the relation between the value of `copy_permission_indicator` and the mode it designates.

`Copy_permission_indicator` is appended to the totality of transport packets. If the input transport stream is recorded using the IEEE1394 digital interface, the value of `copy_permission_indicator` may be associated with the value of EMI (encryption mode indicator). If the input transport stream is recorded without employing the IEEE1394 digital interface, the value of `copy_permission_indicator` may be associated with the value of the CCI embedded in the transport packet. If an analog signal input is self-encoded, the value of `copy_permission_indicator` may be associated with the value of CGMS-A of the analog signal.

`Arrival_time_stamp` is an integer having a value as specified by `arrival_time_stamp` in the following equation:

$$\text{arrival\_time\_stamp}(k) = \text{arrival\_time\_clock}(k) \% 230.$$

By way of defining the ClipAV stream, the ClipAV stream must have a structure of the DVR MPEG 2 transport stream defined as described above. `Arrival_time_clock(i)` must increase continuously in the Clip AV stream. If there exists a discontinuous point of the system time base (STC base) in the Clip AV stream, `arrival_time_clock(i)` in the Clip AV stream must increase continuously.

The maximum value of the different of the `arrival_time_clock(i)` between the

beginning and the end of the Clip AV stream must be 26 hours. This limitation guarantees that, if there is no discontinuous point in the system time base (STC base) in the MPEG 2 transport stream, the PTS (presentation time stamp) of the same value never appears in the Clip AV stream. The MPEG 2 system standard provides that the PTS has a wraparound period of 233/90000 sec (about 26.5 hours).

By way of defining the Bridge-Clip AV stream, the Bridge-Clip AV stream must have a structure of the DVR MPEG 2 transport stream defined as described above. The Bridge-Clip AV stream must include a discontinuous point of one arrival time base. The transport stream ahead and at back of the discontinuous point of the arrival time base must obey the encoding limitations and the DVR-STD as later explained.

The present embodiment supports the video-audio seamless connection between PlayItems being edited. Seamless connection between PlayItems guarantees "continuous data supply" to the player/decoder and "seamless decoding processing". The "continuous data supply" is the capability of guaranteeing data supply to the decoder at a bitrate necessary to prevent buffer underflow. In order to enable data to be read out from the disc as data real-time properties are assured, data is to be stored in terms of a continuous block of a sufficiently large size as a unit.

The "seamless decoding processing" means the capability of a player in displaying audio video data recorded on the disc without producing pause or gap in the playback output of the decoder.

The AV stream, referenced by the seamless connected PlayItems, is explained.

Whether or not the seamless display of a previous PlayItem and the current PlayItem is guaranteed may be verified from the connection\_condition field defined in the current PlayItem. There are two methods for seamless connection of PlayItems, that is a method employing Bridge-Clip and a method not employing Bridge-Clip.

Fig.88 shows the relation between the previous PlayItem and the current PlayItem in case of employing Bridge-Clip. In Fig.88, the stream data, read out by the player, is shown shaded. In Fig.88, TS1 is made up of shaded stream data of the Clip1 (Clip AV stream) and shaded stream data previous to RSPN\_arrival\_time\_discontinuity.

The shaded stream data of Clip1 of TS1 is stream data from an address of a stream required for decoding the presentation unit corresponding to IN\_item of the previous PlayItem (shown as IN-time1 in Fig.88) up to the source packet referenced by RSPN\_exit\_from\_previous\_Clip. The shaded stream data prior to RSPN\_arrival\_time\_discontinuity of Bridge-Clip contained in TS1 is stream data as from the first source packet of Bridge-Clip up to the source packet directly previous to the source packet referenced by RSPN\_arrival\_time\_discontinuity.

In Fig.88, TS2 is made up of shaded stream data of Clip 2 (Clip AV stream) and shaded stream data subsequent to RSPN\_arrival\_time\_discontinuity of Bridge-Clip. The shaded stream data as from the RSPN\_arrival\_time\_discontinuity of Bridge-Clip contained in TS2 stream data from the source packet referenced by RSPN\_arrival\_time\_discontinuity to the last source packet of Bridge-Clip. The shaded

stream data of Clip2 of TS2 is stream data from the source packet referenced by RSPN\_enter\_to\_current\_Clip to the address of the stream required for decoding the presentation unit corresponding to OUT\_time of current PlayItem (shown by OUT\_time2 in Fig.88).

Fig.89 shows the relation between the previous PlayItem and the current PlayItem in case of not employing Bridge-Clip. In this case, the stream data read out by the player is shown shaded. In Fig.89, TS1 is made up of shaded stream data of the Clip1 (Clip AV stream). The shaded stream data of Clip1 of TS1 is data beginning at an address of a stream necessary in decoding a presentation unit corresponding to IN\_time of the previous PlayItem, shown at IN\_time1 in Fig.89 as far as the last source packet of Clip1.

In Fig.89, TS2 is shaded stream data of Clip2 (Clip AV stream).

The shaded stream data of Clip2 of TS2 is stream data beginning at a first source packet of Clip2 as far as an address of the stream necessary for decoding the presentation unit corresponding to OUT\_time of current PlayItem (shown at OUT\_time2 in Fig.89).

In Figs.88 and 89, TS1 and T2 are continuous streams of the source packet. Next, the stream provisions of TS1 and TS2 and the connection conditions therebetween are scrutinized. First, encoding limitations for seamless connection are scrutinized. By way of limitations on the encoding structure of a transport stream, the number of programs contained in TS1 and TS2 must be 1. The number of video

streams contained in TS1 and TS2 must be 1. The number of audio streams contained in TS and TS2 must be 2 or less. The numbers of the audio streams contained in TS1 and TS2 must be equal to each other. It is also possible for elementary streams or private streams other than those depicted above to be contained in TS1 and/or TS2.

The limitations on the video bitstream are now explained. Fig.90 shows a typical seamless connection indicated by a picture display sequence. In order for a video stream to be demonstrated seamlessly in the vicinity of a junction point, unneeded pictures displayed at back of OUT\_time1 (OUT\_time of Clip1) and ahead of IN\_time2 (IN\_time of Clip2) must be removed by a process of re-encoding the partial stream of the Clip in the vicinity of the junction point.

Fig.91 shows an embodiment of realizing seamless connection using BridgeSequence. The video stream of Bridge-Clip previous to RSPN\_arrival\_time\_discontinuity is comprised of an encoded video stream up to a picture corresponding to OUT\_time1 of Clip1 of Fig.90. This video stream is connected to the video stream of previous Clip1 and is re-encoded to form an elementary stream conforming to the MPEG2 standard.

The video stream of Bridge-Clip subsequent to RSPN\_arrival\_time\_discontinuity is made up of an encoded video stream subsequent to a picture corresponding to IN\_time2 of Clip2 of Fig.90. The decoding of this video stream can be started correctly for connecting the video stream to the next following Clip2 video stream. Re-encoding is made such that a sole continuous elementary

stream conforming to MPEG 2 standard will be formed. For creating Bridge-Clip, several pictures in general need to be re-encoded, whilst other pictures can be copied from the original Clip.

Fig.92 shows an embodiment of realizing seamless connection without employing BridgeSequence in the embodiment shown in Fig.90. The Clip1 video stream is comprised of an encoded video stream as far as the picture corresponding to OUT\_time1 of Fig.90 and is re-encoded so as to give an elementary stream conforming to the MPEG2 standard. In similar manner, the video stream of Clip2 is made up of encoded bitstreams subsequent to the picture associated with IN\_time2 of Clip2 of Fig.90. These encoding bitstreams are already re-encoded to give a sole continuous elementary stream conforming to the MPEG2 standard.

By way of explaining encoding limitations of the video stream, the frame rates of the video streams of TS1 and TS2 must be equal to each other. The video stream of TS1 must be terminated at sequence\_end\_code. The video stream of TS2 must commence at Sequence header, GOP Header and with an I-picture. The video stream of TS2 must commence at a closed GOP.

The video presentation units defined in a bitstream (frame or field) must be continuous with a junction point in-between. No gap of the fields or frames are allowed to exist at junction points. In case of encoding employing 3-2 pulldown, it may be necessary to rewrite "top\_field\_first" and "repeat\_first\_field" flags. Alternatively, local

re-encoding may be made to prevent field gaps from being produced.

By way of explaining encoding limitations on the audio bitstream, the audio sampling frequency of TS1 and that of TS2 must be equal to each other. The audio encoding method of TS1 and that of TS2 (for example, MPEG1 layer 2, AC-3, SESF, LPCM and AAC) must be equal to each other.

By way of explaining encoding limitations on MPEG-2 transport stream, the last audio frame of the audio stream of TS1 must contain audio samples having a display timing equal to the display end time of the last display picture of TS1. The first audio frame of the audio stream of TS2 must contain an audio sample having a display timing equal to the display start timing of the first display picture of TS2.

At a junction point, no gap may be allowed to exist in a sequence of the audio presentation units. As shown in Fig.93, there may be an overlap defined by the length of the audio presentation unit less than two audio frame domains. The first packet transmitting an elementary stream of TS2 must be a video packet. The transport stream at the junction point must obey the DVR-STD which will be explained subsequently.

By way of explaining limitations on the Clip and Bridge-Clip, no discontinuities in the arrival time base are allowed to exist in TS1 or in TS2.

The following limitations are applied only to the case of employing the Bridge-Clip. The Bridge-Clip AV stream has a sole discontinuous point in the arrival time base only at a junction point of the last source packet of TS1 and the first source packet of TS2. The `SPN_arrival_time_discontinuity` defined in `ClipInfo()` represents an

address of the discontinuous point, which must represent the address referencing the first source packet of TS2.

The source packet referenced by RSPN\_exit\_from\_previous\_Clip defined in BridgeSequenceInfo() may be any source packet in Clip1. It is unnecessary for this source packet to be a boundary of the Aligned unit. The source packet referenced by RSPN\_enter\_to\_current\_Clip defined in BridgeSequenceInfo() may be any source packet in Clip2. It is unnecessary for this source packet to be a boundary of the Aligned unit.

By way of explaining limitations on PlayItem, the OUT\_time of the previous PlayItem (OUT\_time1 shown in Fig.89) must represent the display end time of the last video presentation unit of TS1. The IN\_time of the current PlayTime (IN\_time2 shown in Fig.88 and 89) must represent the display start time of the first presentation unit of TS2.

By way of explaining the limitations on the data allocation in case of employing Bridge-Clip by referring to Fig.94, the seamless connection must be made to guarantee continuous data supply by the file system. This must be realized by arranging the Bridge-Clip AV stream, connecting to Clip1 (Clip AV stream file) and Clip2 (Clip AV stream file), such as to satisfy data allocation prescriptions.

RSPN\_exit\_from\_previous\_Clip must be selected so that the stream portion of Clip1 (Clip AV stream file) previous to RSPN\_exit\_from\_previous\_Clip will be arranged in a continuous area not less than half fragment. The data length of the

Bridge-Clip AV stream must be selected so that the data will be arranged in the continuous area not less than half fragment. RSPN\_enter\_to\_current\_Clip must be selected so that the stream portion of Clip2 (Clip AV stream file) subsequent to RSPN\_enter\_to\_current\_Clip will be arranged in a continuous area not less than half fragment.

By way of explaining data allocation limitations in case of seamless connection not employing Bridge-Clip, by referring to Fig.95, the seamless connection must be made so as to guarantee continuous data supply by the file system. This must be realized by arranging the last portion of the Clip1 (Clip AV stream file) and the first portion of the Clip2 (Clip AV stream file) so that the provisions on data allocation will be met.

The last stream portion of Clip1 (Clip AV stream file) must be arranged in a continuous area not less than one half fragment. The first stream portion of Clip2 (Clip AV stream file) must be arranged in a continuous area not less than one half fragment. Next, DVR-STD is explained. This DVR-STD is a conceptual model for modeling the decoding processing in the generation and verification of the DVR MPEG 2 transport stream. The DVR-STD is also a conceptual model for modeling the decoding processing in the generation and verification of the AV stream referenced by two PlayItems seamlessly connected to each other as described above.

Fig.96 shows a DVR-STD model. The model shown in Fig.96 includes, as a constituent element, a DVR MPEG 2 transport stream player model. The notation of

$n$ ,  $T_{Bn}$ ,  $M_{Bn}$ ,  $E_{Bn}$ ,  $T_{Bsys}$ ,  $B_{sys}$ ,  $R_{xn}$ ,  $R_{bxn}$ ,  $R_{xsys}$ ,  $D_n$ ,  $D_{sys}$ ,  $O_n$  and  $P_n(k)$  is the same as that defined in T-STD of ISO/IEC 13818-1, wherein  $n$  is an index number of an elementary stream and  $T_{Bn}$  is a transport buffer of the elementary stream  $n$ .

$MB_n$  is a multiplexing buffer of the elementary stream  $n$  and exists only for the video stream.  $EB_n$  is an elementary stream buffer of the elementary stream  $n$  and is present only for the video stream.  $T_{Bsys}$  is a main buffer in a system target decoder for the system information for a program being decoded.  $R_{xn}$  is a transmission rate with which data is removed from  $T_{Bn}$ .  $R_{bxn}$  is a transmission rate with which the PES packet payload is removed from  $MB_n$  and is present only for a video stream.

$R_{xsys}$  is a transmission rate with which data is removed from  $T_{Bsys}$ .  $D_n$  is a decoder of the elementary stream  $n$ .  $D_{sys}$  is a decoder pertinent to the system information of a program being decoded.  $O_n$  is a re-ordering buffer of the video stream  $n$ .  $P_n(k)$  is a number  $k$  presentation unit of the elementary stream.

The decoding process for DVR-STD is explained. During the time a sole DVR MPEG 2 transport stream is being reproduced, the timing of inputting the transport packet to  $TB_1$ ,  $T_{Bn}$  or  $T_{Bsys}$  is determined by `arrival_time_stamp` of the source packet. The prescriptions for the buffering operation of  $TB_1$ ,  $MB_1$ ,  $EB_1$ ,  $T_{Bn}$   $B_n$ ,  $T_{Bsys}$  and  $B_{sys}$  are the same as those of the T-STD provided for in ISO/IEC 13818-1, while the prescriptions for the deciding and display operations are also the same as the T-STD provided for in ISO/IEC 13818-1.

The decoding process during the time the seamlessly connected PlayLists are

being reproduced is now explained. Here, the reproduction of two AV streams referenced by the seamlessly connected PlayItems is explained. In the following explanation, the reproduction of TS1 and TS2, shown for example in Fig.88, is explained. TS1 and TS2 are a previous stream and a current stream, respectively.

Fig.97 shows a timing chart for inputting, decoding and display of transport packets when transferring from a given AV stream (TS1) to the next AV stream seamlessly connected thereto (TS2). During transfer from a preset AV stream (TS1) to the next AV stream seamlessly connected thereto (TS2), the time axis of the arrival time base of TS2 is not the same as the time axis of the arrival time base of TS1 (indicated by ATC1 in Fig.97).

Moreover, the time axis of the system time base of TS2 (indicated by ATC1 in Fig.97) is not the same as the time axis of the system time base of TS1 (indicated by STC1 in Fig.97). The video display is required to be continuous seamlessly, however, there may be overlap in the display time of the presentation units.

The input timing to DVR-STD is explained. During the time until time T1, that is until the inputting of the last video packet to the TB1 of DVR-STD, the input timing to the buffers of TB1, TBn or TBsys of DVR-STD is determined by arrival\_time\_stamp of the arrival time base of TS1.

The remaining packets of TS1 must be input to buffers of TBn or to TBsys of DVR-STD at a bitrate of TS\_recording\_rate (TS1). The TS\_recording\_rate (TS1) is the value of TS\_recording\_rate defined in ClipInfo() corresponding to Clip1. The time

the last byte of TS1 is input to the buffer is the time T2. So, during the time between time T1 and time T2, arrival\_time\_stamp of the source packet is discounted.

If N1 is the number of bytes of the transport packet of TS1 next following the last video packet of TS1, the time DT1 from time T1 until time T2 is the time necessary for N1 bytes to be input completely at a bitrate of TS\_recording\_rate (TS1), and is calculated in accordance with the following equation:

$$DT1 = T2 - T1 = N1/TS\_recording\_rate.$$

During the time from time T1 until time T2 (TS1), both the values of RXn and RXsys are changed to the value of TS-recording\_rate (TS1). Except this rule, the buffering operation is the same as that of T-STD.

At time T2, the arrival time clock counter is reset to the value of arrival\_time\_stamp of the first source packet of TS2. The input timing to the buffer of TB1, TBn or TBsys of DVR-STD is determined by arrival\_time\_stamp of the source packet of TB2. Both RXn and RXsys are changed to values defined in T-STD.

By way of explaining additional audio buffering and system data buffering, the audio decoder and the system decoder need to have an additional buffering amount (data amount equivalent to one second) in addition to the buffer amount defined in T-STD in order to allow input data of a domain from time T1 to time T2.

By way of explaining the video presentation timing, the display on the video presentation unit must be continuous, that is devoid of gaps, through junction point. It is noted that STC1 is the time axis of the system time base of TS1 (indicated as STC1

in Fig.9), while STC2 is the time axis of the system time base of TS2 (shown at STC2 in Fig.97; correctly, STC2 begins at time the first PCR of TS2 has been input to the T-STD).

The offset between STC1 and STC2 is determined as follows: the PTS1end is the PTS on STC1 corresponding to the last video presentation unit of TS2. PTS2start is PTS on STC2 corresponding to the first video presentation unit of TS2 and Tpp is the display time period of the last video presentation unit of TS1, the offset STC\_delta between two system time bases is calculated in accordance with the following equation:

$$\text{STC\_delta} = \text{PTS1end} + \text{Tpp} - \text{PTS2start}.$$

By way of explanation of the audio presentation timing, there may be overlap in the display timing of the audio presentation unit, with the overlap being less than 0 to 2 audio frames (see "audio overlap" shown in Fig.97). The indication as to which of audio samples is to be selected and re-synchronization of the display of the audio presentation unit to the corrected time base at back of the junction point are set on the player.

By way of explaining the system time clock of DVR-STD, the last audio presentation unit of TS1 is displayed at time T5. The system time clock may be overlapped between time T2 and time T5. During this time domain, the DVR-STD switches the system time clocks between the value of the old time base (STC1) and the value of the new time base (STC2). The value of STC2 may be calculated in accordance with the following equation:

$STC2 = STC1 - STC\_delta.$

The buffering continuity is explained.  $STC11video\_end$  is the value of STC on the system time base STC2 when the first byte of the first video packet reaches TB1 of DVR-STD.  $STC22video\_start$  is the value of STC on the system time base STC2 when the first byte of the first video packet reaches TB1 of DVR-STD.  $STC21video\_end$  is the value of  $STC11video\_end$  calculated as the value on STC2 of the system time base STC2.  $STC21video\_end$  is calculated in accordance with the following equation:

$$STC21video\_end = STC11video\_end - STC\_delta.$$

In order to obey DVR-STD, the following two conditions must be met: First, the arrival timing of the first video packet of TS2 at TB1 must satisfy the following inequality:

$$STC22video\_start > STC21video\_end + \Delta T1.$$

If it is necessary to re-encode and/or multiplex the partial stream of Clip1 and/or Clip2, in such a manner that the above inequality will be satisfied, this re-encoding or multiplexing is performed as appropriate.

Second, the inputting of the video packet from TS1 followed by the inputting of the video packet from TS2 on the time axis of the system time base, mapped from STC1 and STC2 on the same time axis, must not overflow or underflow the video buffer.

If the above syntax, data structure and the rules are used as basis, the contents

of data recorded on the recording medium or the reproduction information can be managed properly to enable the user to confirm the contents of data recorded on the recording medium at the time of reproduction or to reproduce desired data extremely readily.

In the above-described embodiment, the MPEG 2 transport stream is taken as an example of the multiplexed stream. This, however, is merely exemplary, such that the MPEG 2 program stream DSS or the transport stream used in the DirecTV Service (trade mark) of USA may also be used as the multiplexed stream.

Fig.98 is a flowchart for illustrating the processing for creating or updating info.dvr. The block diagram showing the recording and/or reproducing apparatus 1 is referenced for explanation.

If a user imposes playback limitations on the disc at step S11, the controller 23 acquires PIN through a user interface.

At step S12, the controller 23 acquires a disc name and/or a thumbnail representative of the disc.

At step S13, the controller 23 stores the filename of a newly recorded Playlist in the TableOfPlaylist.

At step S14, the controller 23 acquires the filename of the last reproduced Playlist.

At step S15, the controller 23 acquires maker private data for a special application of the maker. This is stored in MakerPrivateData.

At step S16, the controller 23 acquires the playback interruption time of the PlayList last reproduced. This is stored in a resume marker of the PlayListMark of the PlayList file.

At step S17, the controller 23 verifies, through a user interface, whether or not a user is to impose playback limitations of the PlayList. The controller 23 sets a playback\_control\_flag of the UIAppInfoPlayList of the PlayList in which the user imposes playback control.

At step S18, the controller 23 issues a command to record info.dvr on a disc.

At step S19, the controller 23 issues a command to record a modified or newly created PlayList file on the disc.

Fig.99 shows a flowchart for illustrating the processing of presenting the recording contents of the disc to the user interface. Reference is made to the block diagram of Fig.1 showing the recording and/or reproducing apparatus 1.

At step S31, the controller 23 acquires the information of info.dvr, Clip Information file, PlayList file and Thumbnail file, recorded on the disc.

If the Volume\_protect\_flag is set, the controller 23 at step S32 requests the user to input PIN through user interface.

At step S33, the controller 23 presents the disc name and the thumbnail representative of the disc contents to GUI through user interface.

At step S34, the controller 23 presents a picture showing a list of the PlayList arraying PlayList names in an entry sequence in the TableOfPlayList to GUI.

If there is the PlayList that can be resumed, the controller 23 at step S35 presents it to GUI.

At step S36, the user commands one PlayList to be reproduced through user interface.

If the playback\_control\_flag of the PlayList commanded is set, the controller 23 at step S37 requests the user to input PIN.

At step S38, the controller 23 inquires of the user whether the PlayList playback start time is to be the leading end time or the resume marker time.

At step S39, the controller 23 reproduces the PlayList as from the designated time point.

In this manner, the disc recording contents are presented to a user interface. The user selects one PlayList desired to be reproduced, with the player then reproducing the so selected PlayList.

Fig.100 is a flowchart for illustrating the processing of changing the playback sequence for plural Playlists if such plural PlayLists are entered in the TableOf PlayList. Reference is made to the block diagram of the recording and/or reproducing apparatus 1 of Fig.1.

At step S51, the controller 23 acquires the information of info.dvr, Clip Information file, PlayList file and Thumbnail file recorded on the disc.

At step S52, the controller 23 presents a picture showing a list of the PlayList arraying PlayList names in an entry sequence in the TableOfPlayList to GUI.

At step S53, the user commands the PlayList playback sequence to be changed through user interface.

At step S54, the controller 23 updates the TableOfPlayList based on the above-mentioned new sequence.

At step S55, the controller 23 commands recording of info.dvr on the disc.

If plural PlayLists are recorded on the disc, and the default playback sequence can be recorded on the TableOfPlayList, the user can set the playback sequence freely.

By using the syntax, data structure and the rule, as described above, as the basis, the contents of data recorded on the recording medium or the playback information can be supervised properly to render it possible for the user to check the contents of data recorded on the recording medium at the time of reproduction, or to reproduce desired data readily. That is, the user may simplify the processing in selecting the desired PlayList using the Info.dvr.

Moreover, by recording the info.dvr file independently of PlayList file or the Clip Information file, the file size of Info.dvr can be reduced appreciably, so that the contents of the Info.dvr file can be changed to shorten the time necessary in recording the file. On the other hand, it is unnecessary to change the PlayList file or the ClipInf file having no relevance to changes in Info.dvr.

If the contents of Info.dvr, PlayList and Clip Information are recorded as one file, the file size is increased appreciably. So, the time needed in changing the file contents to record the change is considerably larger than if only info.dvr is recorded in

one file.

If the PlayList is newly recorded (Fig.98) or if the user changes the playback sequence (Fig.100), the info.dvr file is rewritten. The info.dvr is rewritten more frequently than PlayList file or Clip Information file, so that management of info.dvr as one file is highly effective to reduce the rewriting processing time.

Since `info.dvr` is a small file, the time needed in reading it from the disc is shorter. If only `Info.dvr` is initially read out and the disc recording contents are presented to the user interface based on the read-out contents (Fig.99), the user waiting time can be shorter.

The above-described sequence of operations may be executed not only by hardware but also by software. If the sequence of operations is to be executed by software, it is installed from a recording medium to a computer in the dedicated hardware of which the program forming the software or a general-purpose personal computer of Fig.38 capable of executing various functions based on a variety of programs installed therein.

The recording medium is constituted not only by a package medium distributed for furnishing the program to the user, in addition to a computer, such as a magnetic disc 221 carrying the program thereon, inclusive of a floppy disc, an optical disc 222, inclusive of a CD-ROM (Compact Disc-Read-Only memory) or a DVD (Digital Versatile Disc), a magneto-optical disc 223, inclusive of a Mini-Disc, or a semiconductor memory 224, but also by a hard disc, inclusive of a ROM 202 carrying

a program and a memory 208, furnished to the user as it is built-in in a computer, as shown in Fig.38.

In the present specification, the steps of the program furnished by the medium include not only the chronological processing in accordance with the sequence indicated, but also the processing performed not chronologically but in parallel or separately.

Additionally, in the specification, the system means an entire apparatus comprised of plural component devices.

## Industrial Applicability

With the information processing method and apparatus, recording medium, program, second information processing method and apparatus recording medium and the program, according to the present invention, the management information may contain the name information pertinent to a name assigned to the playback designation information at the time of completion of playback which is based on the playback designation information, with the playback designation information containing the temporal information as to time point of the completion of playback which is based on the playback designation information.

With the information processing method and apparatus, recording medium, program, fourth information processing method and apparatus, recording medium and the program, according to the present invention, the management information may

contain the reading permission information pertinent to permission of reading of the totality of the playback designation information supervised by the management information, with the playback designation information containing the reading permission information pertinent to permission of reading of the playback designation information.

With the information processing method and apparatus, recording medium and the program, according to the present invention, the management information may contain the playback sequence information for registering the totality of the playback designation information supervised by the management information, in a playback sequence, with the playback designation information containing the temporal information of its playback domain.

Therefore, in any case, the data contents and the playback information recorded on the recording medium can be supervised adequately.